37HS
Moduline® Air Terminals

Application Data

CONTENTS

INTRODUCTION

The Moduline® air terminal (Fig. 1) is a truly flexible unit for the control and distribution of conditioned air to the occupied space. Available in 3 airflow sizes for single or multiple terminal installation, it is adaptable to a variety of

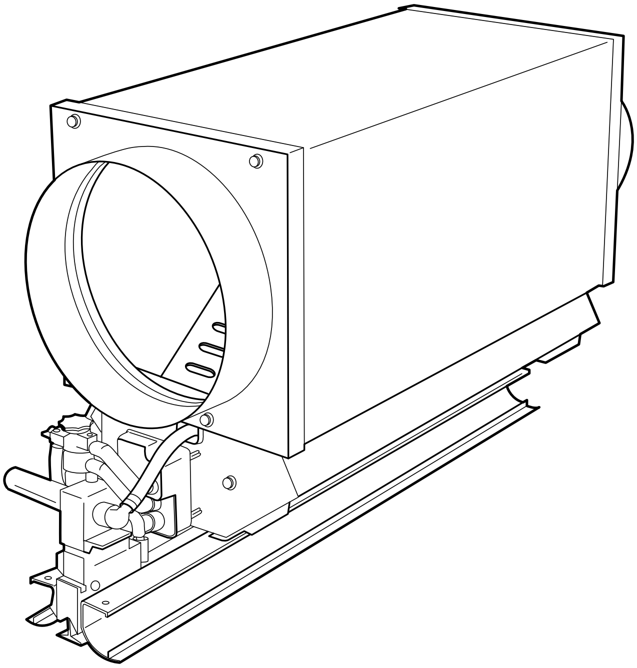


Fig. 1 — Moduline Air Terminal

Book 3 Tab 6a | PC 201 | Catalog No. 513-741 | Printed in U.S.A. | Form 37HS-1XA | Pg 1 | 6-91 | Replaces: New

ceiling designs and building control systems. Moduline® terminals installed in modular ceilings can be moved easily when tenant requirements change, and the quiet, linear slot distribution integrates well in most commercial ceilings. Figure 2 shows a 37HS Moduline unit with variable air volume (VAV) controls.

The basic Moduline terminal control system is system powered; the distribution duct pressure provides the energy to operate the devices that control all the units in the system. This system can be thought of as reactive. The control reacts to changes in occupied space conditions and to changes in supply duct airflow and pressure, and adjusts the unit valve to maintain preset airflow or flow proportional to the room load.

It is also possible to apply directive controls, both pneumatic and electric, to the Moduline terminal. In these applications, the Moduline control system is still system powered. The difference is that now the space can be controlled by other sensors and devices, replacing the reactive control devices.

This application data book provides design guidance for layout of a Moduline system. All aspects of the unit application are included: Unit layout, control location, control

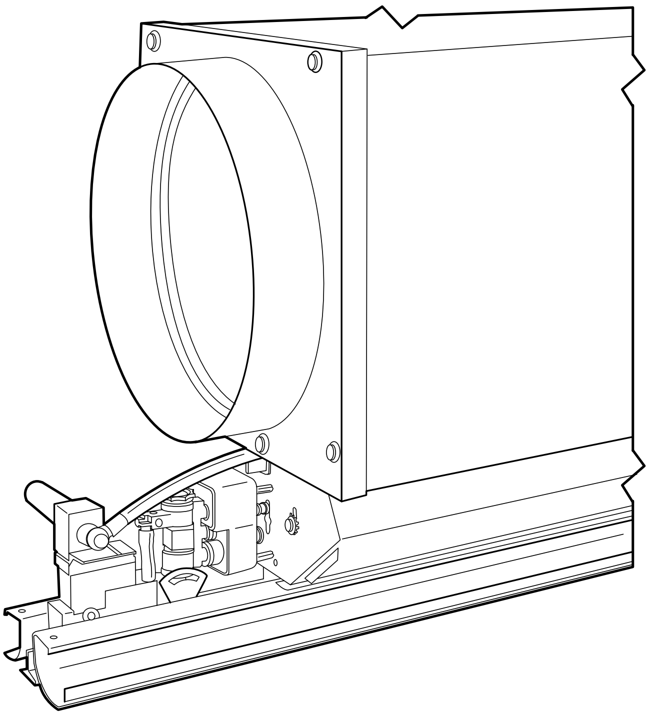


Fig. 2 — 37HS Unit With VAV Controls

characteristics, control system options and air distribution characteristics. This book covers both system-powered control and system-powered with electric or pneumatic interface controls. Application information for Carrier's electronic Product Integrated Controls (PIC) can be found in a separate publication. (Moduline units with PIC controls can be controlled as part of the Carrier Comfort Network [CCN] system.) Sound power levels and sound application data are found in the 37HS Sound Application Data book. Specific mounting and installation data is found in the 37HS Installation, Start-Up and Service instructions or, for PIC units, in the 37HC Installation, Start-Up and Service Instructions.

BUILDING LOAD CALCULATION

Cooling — In order to select Moduline equipment and lay out the building air distribution system, it is first necessary to calculate the building cooling and heating loads which the Moduline terminals will offset.

The first step is to determine the complete ''block'' load for the building in order to size the fan, cooling equipment and trunk duct. This estimate is for the month and hour of greatest total building load. (See Fig. 3.)

The next step is to estimate each zone load (sensible heat only). These are used to size the terminals and run-out ducts. The zone peak load estimates are for different months and hours, depending on zone window orientation. (See Fig. 4.)

These calculations are made for a building which will utilize Moduline units in both perimeter and interior spaces. The Moduline system supplies all building cooling. The heating system is described on page 20.

The object of making these load estimates is to arrive at the required air volumes, so that the system can be designed and equipment selected.

The airflow through a variable volume system is constantly changing in response to the changes in the building cooling loads. At any one moment the airflow to each temperature control zone is determined by the room sensible heat cooling load (RSH), the supply air temperature (T_{SA}) and the room thermostat setting (T_R), as shown in the following equation:

$$\text{Zone cfm} = \frac{\text{RSH}}{1.09^* (T_R - T_{SA})}$$

*1.09 is constant in this formula.

The fan airflow at the same moment is the sum of all the zone airflow rates. (Duct leakage is assumed to be negligible because of the high quality duct construction required by VAV systems.)

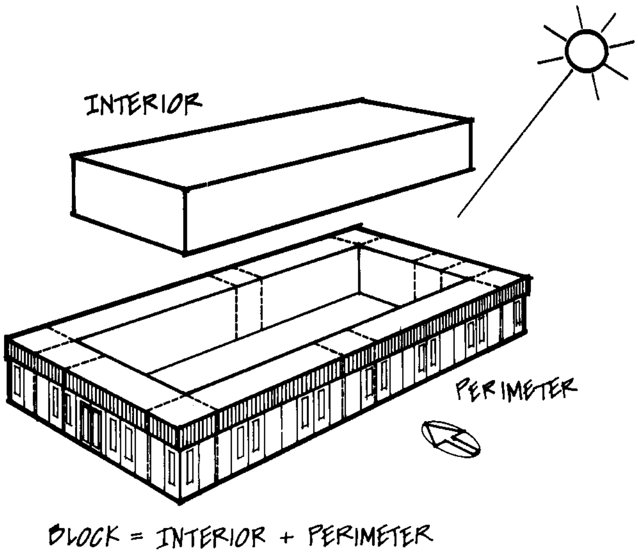


Fig. 3 — Estimating Block Load

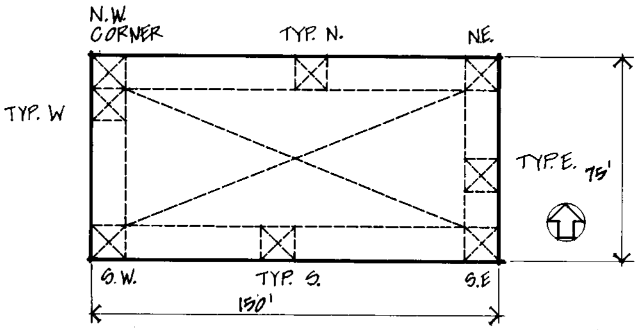


Fig. 4 — Floor Plan of Typical Zones for Single-Story Office Building

LOAD CONSIDERATIONS

Lighting — Even though lighting loads (Watts/sq ft) are considerably lower in today's buildings, the lighting is by far the largest load component.

It is necessary, therefore, to pay close attention to getting an accurate estimate of the lighting requirements.

In estimating the lighting load, special consideration should be given to evaluating storage effect and the performance of return air ceiling plenums. Both of these items reduce the peak room load from lights and delay the time at which the stored heat becomes a load on the central equipment.

Oversizing — Oversizing of variable volume systems results in unused equipment capacity and worse performance at part load, not in increased system airflow. The *actual* system operation will reflect the *actual* system load, not the design load. If conservative data, safety factors, or provision for future loads are included in the design estimate, the actual system airflow will *not* be increased. The equipment will be capable of handling an increased load should it ever exist, but will automatically throttle back to handle only the actual load at that moment.

It is recommended that safety factors not be included in load calculations; they are not included in the following method.

Air Motion, Ventilation and Odor Dilution — Air motion, ventilation, and odor dilution deserve special attention in the design of a VAV system. The designer must visualize the correct system operating condition in order to evaluate the adequacy of these items at either full or part-load cooling conditions, or during the heating season.

Room air motion is determined by the supply air quantity and the diffuser induction ratio. The minimum room air velocity is higher if building humidity and temperature are higher. The design cfm at peak cooling load in any zone should be not less than the minimum shown below:

DESIRED ROOM TEMPERATURE (F)	DESIGN CFM AT PEAK COOLING (cfm/sq ft)
78	0.7
75	0.4

These minimums are based on using the Carrier Moduline diffuser, which has very high performance; competitive diffusers require a higher cfm/sq ft.

The outside air cfm requirement at maximum design conditions may be determined by local building code. If the outside air cfm to the central air handler is adequate to maintain a low overall building odor level, the odor level in a particular space will depend upon the odors generated locally in that space and the supply airflow to that space. A space with high odor generation (a conference room with much smoking) should be provided with a separate exhaust system to increase the air flow through the space for odor dilution. The only way to increase the VAV airflow to that space would be to add reheat to increase the room sensible heat, which is unacceptable from an energy conservation standpoint.

The following odor dilution cfm (either VAV supply or supplemental exhaust cfm) is usually adequate:

Private or General Office — 0.25 cfm/sq ft
Major Conference Room — 1.0 cfm/sq ft

Supply Air Temperature — In systems using draw-thru air handling units and high induction Carrier Moduline® terminal units, the acceptable range of supply air temperatures at the terminals is from 50 to 54 F. The cooling coil ADP (Apparatus Dew Point) will be from 3 to 5° F lower than the supply air temperature, due to allowance for coil bypass, fan heat and duct gain.

The system installed cost for ductwork, central air handler, and VAV terminals will be greater if the air quantity is higher because of the designer's choice of a higher supply air temperature. The increased fan air quantity will result in higher fan operating cost, which may be offset by the lower cost of operating the refrigeration system at a higher suction temperature. The higher coil surface temperature (ADP) of the system will result in a higher building humidity, which will be less comfortable and require greater ventilation air.

An unduly low choice of supply air temperature may result in unacceptably low room air motion in interior zones with low lighting levels, and in unnecessarily low humidity.

The same supply air temperature must be used for the zone load and block load estimates.

Load Calculating Methods — The cooling load estimates can be made very accurately and quickly using the Carrier E20-II Block Load program.

Because of the computer's speed, it is not necessary to compromise the design procedure to obtain the most accurate result. The optimum design procedure listed here assumes the use of the E20-II program, and may require ''short cuts'' when using manual methods.

While the E-20 program is the most convenient and rapid method of load calculation, other methods will also provide the required results. In particular, Carrier multi-room load estimating form E-5056 is available for this purpose.

DESIGN PROCEDURE (with example)

Data Collection — Our example uses Cincinnati, Ohio as a representative city. The building is a one-story office building with 11,250 sq ft. The building layout is shown in Fig. 4 on page 3.

1. Using the E20-II Block Load Program, select Cincinnati for its weather data. The WEATHER PARAMETERS printout shown on pages 5 and 6 shows the weather data used for the load estimating calculations.
2. The next step is to gather data on the building, including dimensions, construction materials used, internal load patterns (such as lighting levels) and the building orientation. For our example, we have divided the building into nine zones. The actual building has ten zones on its north exposure, but we've grouped them all into a single zone because zones on the same exposure tend to have similar load patterns. Similarly, the ten south exposure zones have been grouped into a single zone, and the four east and west zones have been combined into single east and west zones respectively.

   Pages 7-15 contain the ZONE DESCRIPTION printouts for each of the nine zones.
3. The final input step is to select an initial set of system design data, including the cooling and heating set points, the supply air temperature (or supply airflow rate, if that is known) and the fan static pressure. This system design data will, of course, be directly influenced by the actual central station equipment, be it packaged or applied.

   Page 16 shows the HVAC SYSTEM DATA printout which lists the system design data we've selected for this example.

Load Calculations — With the input data from Step 1, the Block Load Program calculates the building loads for each month of the year to find the largest load on the building's air conditioning system. Typically, this will occur during the middle or late afternoon hours in July or August. The SYSTEM SIZING SUMMARY printout shown on pages 17 and 18 provides both the cooling and heating equipment sizing data. At the same time, it provides the maximum cooling load, maximum heating load and design airflow rate for each zone in the building. Notice that each zone may peak at a month and hour different from that at which the HVAC system peaks. The detailed system load report is shown on page 19.

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TABLE 1. DESIGN PARAMETERS

City Name	Cincinnati
Location	Ohio
Latitude	39.2 deg
Elevation	761.0 ft
Summer Design Dry Bulb Temp	92.0 F
Summer Coincident Wet Bulb Temp	73.0 F
Daily Temperature Range	21.0 F
Winter Design Dry Bulb Temp	1.0 F
Atmospheric Clearness Number	0.95

TABLE 2. MAXIMUM DAILY SOLAR HEAT GAINS (BTU/hr/sqft)

Month	NE	E	SE	S	SW	W	NW	N	Hor
Jan	19.0	148.5	230.5	241.4	230.5	148.5	19.0	19.0	130.6
Feb	49.0	178.3	233.9	227.3	233.9	178.3	49.0	23.1	174.7
Mar	90.0	207.8	223.5	193.3	223.5	207.8	90.0	27.7	214.5
Apr	133.9	212.9	191.5	142.9	191.5	212.9	133.9	32.2	241.2
May	157.3	209.0	164.0	103.1	164.0	209.0	157.3	35.4	253.2
Jun	164.1	204.7	150.9	87.0	150.9	204.7	164.1	45.1	255.2
Jul	155.0	204.9	159.9	100.1	159.9	204.9	155.0	36.2	250.2
Aug	129.0	205.4	184.8	138.1	184.8	205.4	129.0	33.8	236.8
Sep	84.4	195.8	214.0	187.6	214.0	195.8	84.4	28.8	207.4
Oct	48.0	172.2	226.4	220.6	226.4	172.2	48.0	23.9	171.6
Nov	19.3	145.9	226.6	237.6	226.6	145.9	19.3	19.3	130.0
Dec	17.1	131.7	222.7	241.0	222.7	131.7	17.1	17.1	111.6

WEATHER PARAMETERS

City Name : Cincinnati
Location : Ohio
Prepared By: Software Systems Network

04-02-91
Block Load v2.01

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TABLE 3. COOLING DESIGN TEMPERATURE PROFILES (DB/WB in F)

Hr	January	February	March	April	May	June
000	30.6/ 30.1	34.6/ 34.1	45.8/ 45.3	55.8/ 55.3	64.8/ 62.4	71.8/ 65.8
100	29.5/ 29.0	33.5/ 33.0	44.7/ 44.2	54.7/ 54.2	63.7/ 62.1	70.7/ 65.5
200	28.5/ 28.0	32.5/ 32.0	43.7/ 43.2	53.7/ 53.2	62.7/ 61.7	69.7/ 65.1
300	27.6/ 27.1	31.6/ 31.1	42.8/ 42.3	52.8/ 52.3	61.8/ 61.3	68.8/ 64.8
400	27.0/ 26.5	31.0/ 30.5	42.2/ 41.7	52.2/ 51.7	61.2/ 60.7	68.2/ 64.6
500	26.8/ 26.3	30.8/ 30.3	42.0/ 41.5	52.0/ 51.5	61.0/ 60.5	68.0/ 64.6
600	27.2/ 26.7	31.2/ 30.7	42.4/ 41.9	52.4/ 51.9	61.4/ 60.9	68.4/ 64.7
700	28.3/ 27.8	32.3/ 31.8	43.5/ 43.0	53.5/ 53.0	62.5/ 61.7	69.5/ 65.1
800	30.2/ 29.7	34.2/ 33.7	45.4/ 44.9	55.4/ 54.9	64.4/ 62.3	71.4/ 65.7
900	32.9/ 32.4	36.9/ 36.4	48.1/ 47.6	58.1/ 57.6	67.1/ 63.2	74.1/ 66.5
1000	36.0/ 35.5	40.0/ 39.5	51.2/ 50.7	61.2/ 58.9	70.2/ 64.3	77.2/ 67.5
1100	39.6/ 39.1	43.6/ 43.1	54.8/ 54.3	64.8/ 60.2	73.8/ 65.5	80.8/ 68.6
1200	43.0/ 42.5	47.0/ 46.5	58.2/ 57.2	68.2/ 61.3	77.2/ 66.5	84.2/ 69.6
1300	45.5/ 43.9	49.5/ 49.0	60.7/ 58.1	70.7/ 62.2	79.7/ 67.3	86.7/ 70.3
1400	47.2/ 44.7	51.2/ 49.7	62.4/ 58.8	72.4/ 62.8	81.4/ 67.8	88.4/ 70.8
1500	47.8/ 45.0	51.8/ 50.0	63.0/ 59.0	73.0/ 63.0	82.0/ 68.0	89.0/ 71.0
1600	47.2/ 44.7	51.2/ 49.7	62.4/ 58.8	72.4/ 62.8	81.4/ 67.8	88.4/ 70.8
1700	45.7/ 44.0	49.7/ 49.1	60.9/ 58.2	70.9/ 62.3	79.9/ 67.4	86.9/ 70.4
1800	43.4/ 42.9	47.4/ 46.9	58.6/ 57.4	68.6/ 61.5	77.6/ 66.6	84.6/ 69.7
1900	40.7/ 40.2	44.7/ 44.2	55.9/ 55.4	65.9/ 60.5	74.9/ 65.8	81.9/ 68.9
2000	37.9/ 37.4	41.9/ 41.4	53.1/ 52.6	63.1/ 59.5	72.1/ 64.9	79.1/ 68.1
2100	35.6/ 35.1	39.6/ 39.1	50.8/ 50.3	60.8/ 58.7	69.8/ 64.1	76.8/ 67.4
2200	33.5/ 33.0	37.5/ 37.0	48.7/ 48.2	58.7/ 57.9	67.7/ 63.4	74.7/ 66.7
2300	31.8/ 31.3	35.8/ 35.3	47.0/ 46.5	57.0/ 56.5	66.0/ 62.9	73.0/ 66.2

Hr	July	August	September	October	November	December
000	74.8/ 68.0	74.8/ 68.0	68.8/ 64.7	58.8/ 58.3	48.6/ 48.1	36.6/ 36.1
100	73.7/ 67.7	73.7/ 67.7	67.7/ 64.3	57.7/ 57.2	47.5/ 47.0	35.5/ 35.0
200	72.7/ 67.4	72.7/ 67.4	66.7/ 64.0	56.7/ 56.2	46.5/ 46.0	34.5/ 34.0
300	71.8/ 67.1	71.8/ 67.1	65.8/ 63.7	55.8/ 55.3	45.6/ 45.1	33.6/ 33.1
400	71.2/ 66.9	71.2/ 66.9	65.2/ 63.5	55.2/ 54.7	45.0/ 44.5	33.0/ 32.5
500	71.0/ 66.9	71.0/ 66.9	65.0/ 63.4	55.0/ 54.5	44.8/ 44.3	32.8/ 32.3
600	71.4/ 67.0	71.4/ 67.0	65.4/ 63.6	55.4/ 54.9	45.2/ 44.7	33.2/ 32.7
700	72.5/ 67.3	72.5/ 67.3	66.5/ 63.9	56.5/ 56.0	46.3/ 45.8	34.3/ 33.8
800	74.4/ 67.9	74.4/ 67.9	68.4/ 64.5	58.4/ 57.9	48.2/ 47.7	36.2/ 35.7
900	77.1/ 68.8	77.1/ 68.8	71.1/ 65.4	61.1/ 59.9	50.9/ 50.4	38.9/ 38.4
1000	80.2/ 69.7	80.2/ 69.7	74.2/ 66.5	64.2/ 61.0	54.0/ 53.5	42.0/ 41.5
1100	83.8/ 70.7	83.8/ 70.7	77.8/ 67.5	67.8/ 62.3	57.6/ 55.9	45.6/ 45.1
1200	87.2/ 71.7	87.2/ 71.7	81.2/ 68.6	71.2/ 63.4	61.0/ 57.2	49.0/ 47.9
1300	89.7/ 72.4	89.7/ 72.4	83.7/ 69.3	73.7/ 64.2	63.5/ 58.1	51.5/ 49.0
1400	91.4/ 72.8	91.4/ 72.8	85.4/ 69.8	75.4/ 64.8	65.2/ 58.8	53.2/ 49.7
1500	92.0/ 73.0	92.0/ 73.0	86.0/ 70.0	76.0/ 65.0	65.8/ 59.0	53.8/ 50.0
1600	91.4/ 72.8	91.4/ 72.8	85.4/ 69.8	75.4/ 64.8	65.2/ 58.8	53.2/ 49.7
1700	89.9/ 72.4	89.9/ 72.4	83.9/ 69.4	73.9/ 64.3	63.7/ 58.2	51.7/ 49.1
1800	87.6/ 71.8	87.6/ 71.8	81.6/ 68.7	71.6/ 63.6	61.4/ 57.3	49.4/ 48.0
1900	84.9/ 71.0	84.9/ 71.0	78.9/ 67.9	68.9/ 62.6	58.7/ 56.3	46.7/ 46.2
2000	82.1/ 70.2	82.1/ 70.2	76.1/ 67.0	66.1/ 61.7	55.9/ 55.2	43.9/ 43.4
2100	79.8/ 69.5	79.8/ 69.5	73.8/ 66.3	63.8/ 60.9	53.6/ 53.1	41.6/ 41.1
2200	77.7/ 68.9	77.7/ 68.9	71.7/ 65.6	61.7/ 60.1	51.5/ 51.0	39.5/ 39.0
2300	76.0/ 68.4	76.0/ 68.4	70.0/ 65.1	60.0/ 59.5	49.8/ 49.3	37.8/ 37.3

ZONE DESCRIPTION FOR North Zone

Prepared By : Software Systems Network — 04-02-91

Block Load Program v2.01

TABLE 1. GENERAL ZONE DATA

ZONE NAME = North Zone

GENERAL ZONE DATA		**PEOPLE**	
Floor Area	: 1562.0 sqft	sqft/person	: 156.2 sqft/per
Building Weight	: M	Unocc Diversity	: 0 %
Exposures	: N, E, S, W	Activity Level	: Office Work
Are Multiple Wall, Roof, or Glass Types Used ?	N	Sensible Gain	: 245.0 BTU/hr/per
		Latent Gain	: 205.0 BTU/hr/per
		MISCELLANEOUS LOADS	
		Sensible	: 0 BTU/hr
No. Partitions	: 0	Latent	: 0 BTU/hr
LIGHTING		Unocc Diversity	: 0 %
W/sqft	: 1.50 W/sqft	**INFILTRATION**	
Unocc Diversity	: 10 %	Cooling	: 0.05 CFM/sqft
Wattage Mult.	: 1.00	Heating	: 0.10 CFM/sqft
Fixture Type	: Recessed, Vented	**SLAB**	
OTHER ELECTRIC		Area	: 1562 sqft
W/sqft	: 0.25 W/sqft	Perimeter	: 125 ft
Unocc Diversity	: 0 %	Depth	: 0.00 ft

TABLE 2. WALL, ROOF AND GLASS DATA

	WALL	ROOF	GLASS	
U-Value (BTU/hr/sqft/F)	0.120	0.080	U-Value	0.550
Weight (lb/sqft)	30	L	Glass Factor	0.63
Color	M	D	Int. Shades ?	Y

EXTERNAL SHADING DATA		Overhang Height	= 0.0 in
Window Height	= 8.0 ft	Overhang Extension	= 0.0 in
Window Width	= 4.0 ft	Fin Separation	= 0.0 in
Reveal Depth	= 0.0 in	Fin Extension	= 0.0 in

Exposure	Gross Area (sqft)	Glass Area (sqft)
E Wall	0.0	0.0
S Wall	0.0	0.0
W Wall	0.0	0.0
N Wall	1,625.0	90.0
Roof (Hor)	1,562.0	0.0

ZONE DESCRIPTION FOR East Zone

Prepared By : Software Systems Network — 04-02-91

Block Load Program v2.01 —

TABLE 1. GENERAL ZONE DATA

ZONE NAME = East Zone

GENERAL ZONE DATA		**PEOPLE**	
Floor Area :	625.0 sqft	sqft/person :	156.2 sqft/per
Building Weight:	M	Unocc Diversity:	0 %
Exposures :	N, E, S, W	Activity Level :	Office Work
Are Multiple Wall, Roof, or Glass Types Used ?	N	Sensible Gain :	245.0 BTU/hr/per
		Latent Gain :	205.0 BTU/hr/per
		MISCELLANEOUS LOADS	
		Sensible :	0 BTU/hr
No. Partitions :	0	Latent :	0 BTU/hr
LIGHTING		Unocc Diversity:	0 %
W/sqft :	1.50 W/sqft	**INFILTRATION**	
Unocc Diversity:	10 %	Cooling :	0.05 CFM/sqft
Wattage Mult. :	1.00	Heating :	0.10 CFM/sqft
Fixture Type :	Recessed, Vented	**SLAB**	
OTHER ELECTRIC		Area :	625 sqft
W/sqft :	0.25 W/sqft	Perimeter :	50 ft
Unocc Diversity:	0 %	Depth :	0.00 ft

TABLE 2. WALL, ROOF AND GLASS DATA

	WALL	ROOF	GLASS	
U-Value (BTU/hr/sqft/F)	0.120	0.080	U-Value	0.550
Weight (lb/sqft)	30	L	Glass Factor	0.63
Color	M	D	Int. Shades ?	Y

EXTERNAL SHADING DATA		Overhang Height =	0.0 in
Window Height =	8.0 ft	Overhang Extension =	0.0 in
Window Width =	4.0 ft	Fin Separation =	0.0 in
Reveal Depth =	0.0 in	Fin Extension =	0.0 in

Exposure	Gross Area (sqft)	Glass Area (sqft)
E Wall	650.0	36.0
S Wall	0.0	0.0
W Wall	0.0	0.0
N Wall	0.0	0.0
Roof (Hor)	625.0	0.0

ZONE DESCRIPTION FOR South Zone

Prepared By : Software Systems Network 04-02-91
Block Load Program v2.01 Page 1 of 1

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TABLE 1. GENERAL ZONE DATA

ZONE NAME = South Zone

GENERAL ZONE DATA		PEOPLE	
Floor Area :	1562.0 sqft	sqft/person :	156.2 sqft/per
Building Weight:	M	Unocc Diversity:	0 %
Exposures :	N, E, S, W	Activity Level :	Office Work
Are Multiple Wall, Roof, or Glass Types Used ?	N	Sensible Gain :	245.0 BTU/hr/per
		Latent Gain :	205.0 BTU/hr/per
		MISCELLANEOUS LOADS	
		Sensible :	0 BTU/hr
No. Partitions :	0	Latent :	0 BTU/hr
LIGHTING		Unocc Diversity:	0 %
W/sqft :	1.50 W/sqft	INFILTRATION	
Unocc Diversity:	10 %	Cooling :	0.05 CFM/sqft
Wattage Mult. :	1.00	Heating :	0.10 CFM/sqft
Fixture Type :	Recessed, Vented	SLAB	
OTHER ELECTRIC		Area :	1562 sqft
W/sqft :	0.25 W/sqft	Perimeter :	125 ft
Unocc Diversity:	0 %	Depth :	0.00 ft

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TABLE 2. WALL, ROOF AND GLASS DATA

	WALL	ROOF	GLASS	
U-Value (BTU/hr/sqft/F)	0.120	0.080	U-Value	0.550
Weight (lb/sqft)	30	L	Glass Factor	0.63
Color	M	D	Int. Shades ?	Y

EXTERNAL SHADING DATA		Overhang Height =	0.0 in
Window Height =	8.0 ft	Overhang Extension =	0.0 in
Window Width =	4.0 ft	Fin Separation =	0.0 in
Reveal Depth =	0.0 in	Fin Extension =	0.0 in

Exposure	Gross Area (sqft)	Glass Area (sqft)
E Wall	0.0	0.0
S Wall	1,625.0	90.0
W Wall	0.0	0.0
N Wall	0.0	0.0
Roof (Hor)	1,562.0	0.0

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ZONE DESCRIPTION FOR West Zone

Prepared By : Software Systems Network 04-02-91

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TABLE 1. GENERAL ZONE DATA

ZONE NAME = West Zone

GENERAL ZONE DATA		PEOPLE	
Floor Area :	625.0 sqft	sqft/person :	156.2 sqft/per
Building Weight:	M	Unocc Diversity:	0 %
Exposures :	N, E, S, W	Activity Level :	Office Work
Are Multiple Wall, Roof, or Glass Types Used ?	N	Sensible Gain :	245.0 BTU/hr/per
		Latent Gain :	205.0 BTU/hr/per
		MISCELLANEOUS LOADS	
		Sensible :	0 BTU/hr
No. Partitions :	0	Latent :	0 BTU/hr
LIGHTING		Unocc Diversity:	0 %
W/sqft :	1.50 W/sqft	INFILTRATION	
Unocc Diversity:	10 %	Cooling :	0.05 CFM/sqft
Wattage Mult. :	1.00	Heating :	0.10 CFM/sqft
Fixture Type :	Recessed, Vented	SLAB	
OTHER ELECTRIC		Area :	625 sqft
W/sqft :	0.25 W/sqft	Perimeter :	50 ft
Unocc Diversity:	0 %	Depth :	0.00 ft

****

TABLE 2. WALL, ROOF AND GLASS DATA

	WALL	ROOF	GLASS	
U-Value (BTU/hr/sqft/F)	0.120	0.080	U-Value	0.550
Weight (lb/sqft)	30	L	Glass Factor	0.63
Color	M	D	Int. Shades ?	Y

EXTERNAL SHADING DATA		Overhang Height =	0.0 in
Window Height =	8.0 ft	Overhang Extension =	0.0 in
Window Width =	4.0 ft	Fin Separation =	0.0 in
Reveal Depth =	0.0 in	Fin Extension =	0.0 in

Exposure	Gross Area (sqft)	Glass Area (sqft)
E Wall	0.0	0.0
S Wall	0.0	0.0
W Wall	650.0	36.0
N Wall	0.0	0.0
Roof (Hor)	625.0	0.0

****

ZONE DESCRIPTION FOR Northeast Zone

Prepared By : Software Systems Network — 04-02-91

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****

TABLE 1. GENERAL ZONE DATA

ZONE NAME = Northeast Zone

GENERAL ZONE DATA		PEOPLE	
Floor Area :	156.0 sqft	sqft/person :	156.0 sqft/per
Building Weight:	M	Unocc Diversity:	0 %
Exposures :	N, E, S, W	Activity Level :	Office Work
Are Multiple Wall, Roof, or Glass Types Used ?	N	Sensible Gain :	245.0 BTU/hr/per
		Latent Gain :	205.0 BTU/hr/per
		MISCELLANEOUS LOADS	
		Sensible :	0 BTU/hr
No. Partitions :	0	Latent :	0 BTU/hr
LIGHTING		Unocc Diversity:	0 %
W/sqft :	1.25 W/sqft	INFILTRATION	
Unocc Diversity:	10 %	Cooling :	0.05 CFM/sqft
Wattage Mult. :	1.00	Heating :	0.10 CFM/sqft
Fixture Type :	Recessed, Vented	SLAB	
OTHER ELECTRIC		Area :	156 sqft
W/sqft :	0.25 W/sqft	Perimeter :	12 ft
Unocc Diversity:	0 %	Depth :	0.00 ft

****

TABLE 2. WALL, ROOF AND GLASS DATA

	WALL	ROOF	GLASS	
U-Value (BTU/hr/sqft/F)	0.120	0.080	U-Value	0.550
Weight (lb/sqft)	30	L	Glass Factor	0.63
Color	M	D	Int. Shades ?	Y

EXTERNAL SHADING DATA			
Window Height =	8.0 ft	Overhang Height =	0.0 in
Window Width =	4.0 ft	Overhang Extension =	0.0 in
Reveal Depth =	0.0 in	Fin Separation =	0.0 in
		Fin Extension =	0.0 in

Exposure	Gross Area (sqft)	Glass Area (sqft)
E Wall	162.5	9.0
S Wall	0.0	0.0
W Wall	0.0	0.0
N Wall	162.5	9.0
Roof (Hor)	156.0	0.0

****

ZONE DESCRIPTION FOR Southeast Zone

Prepared By : Software Systems Network 04-02-91

Block Load Program v2.01 Page 1 of 1

****

TABLE 1. GENERAL ZONE DATA

ZONE NAME = Southeast Zone

GENERAL ZONE DATA		**PEOPLE**	
Floor Area :	156.0 sqft	sqft/person :	156.0 sqft/per
Building Weight:	M	Unocc Diversity:	0 %
Exposures :	N, E, S, W	Activity Level :	Office Work
Are Multiple		Sensible Gain :	245.0 BTU/hr/per
Wall, Roof,		Latent Gain :	205.0 BTU/hr/per
or Glass		**MISCELLANEOUS LOADS**	
Types Used ?	N	Sensible :	0 BTU/hr
No. Partitions :	0	Latent :	0 BTU/hr
LIGHTING		Unocc Diversity:	0 %
W/sqft :	1.25 W/sqft	**INFILTRATION**	
Unocc Diversity:	10 %	Cooling :	0.05 CFM/sqft
Wattage Mult. :	1.00	Heating :	0.10 CFM/sqft
Fixture Type :	Recessed, Vented	**SLAB**	
OTHER ELECTRIC		Area :	156 sqft
W/sqft :	0.25 W/sqft	Perimeter :	12 ft
Unocc Diversity:	0 %	Depth :	0.00 ft

****

TABLE 2. WALL, ROOF AND GLASS DATA

	WALL	ROOF	GLASS	
U-Value (BTU/hr/sqft/F)	0.120	0.080	U-Value	0.550
Weight (lb/sqft)	30	L	Glass Factor	0.63
Color	M	D	Int. Shades ?	Y

EXTERNAL SHADING DATA		Overhang Height =	0.0 in
Window Height =	8.0 ft	Overhang Extension =	0.0 in
Window Width =	4.0 ft	Fin Separation =	0.0 in
Reveal Depth =	0.0 in	Fin Extension =	0.0 in

Exposure	Gross Area (sqft)	Glass Area (sqft)
E Wall	162.5	9.0
S Wall	162.5	9.0
W Wall	0.0	0.0
N Wall	0.0	0.0
Roof (Hor)	156.0	0.0

****

ZONE DESCRIPTION FOR Southwest Zone

Prepared By : Software Systems Network 04-02-91
Block Load Program v2.01

****

TABLE 1. GENERAL ZONE DATA

ZONE NAME = Southwest Zone

GENERAL ZONE DATA	
Floor Area :	156.0 sqft
Building Weight:	M
Exposures :	N, E, S, W
Are Multiple Wall, Roof, or Glass Types Used ?	N
No. Partitions :	0
LIGHTING	
W/sqft :	1.25 W/sqft
Unocc Diversity:	10 %
Wattage Mult. :	1.00
Fixture Type :	Recessed, Vented
OTHER ELECTRIC	
W/sqft :	0.25 W/sqft
Unocc Diversity:	0 %
PEOPLE	
sqft/person :	156.0 sqft/per
Unocc Diversity:	0 %
Activity Level :	Office Work
Sensible Gain :	245.0 BTU/hr/per
Latent Gain :	205.0 BTU/hr/per
MISCELLANEOUS LOADS	
Sensible :	0 BTU/hr
Latent :	0 BTU/hr
Unocc Diversity:	0 %
INFILTRATION	
Cooling :	0.05 CFM/sqft
Heating :	0.10 CFM/sqft
SLAB	
Area :	156 sqft
Perimeter :	12 ft
Depth :	0.00 ft

****

TABLE 2. WALL, ROOF AND GLASS DATA

	WALL	ROOF	GLASS	
U-Value (BTU/hr/sqft/F)	0.120	0.080	U-Value	0.550
Weight (lb/sqft)	30	L	Glass Factor	0.63
Color	M	D	Int. Shades ?	Y

EXTERNAL SHADING DATA

Window Height	=	8.0 ft
Window Width	=	4.0 ft
Reveal Depth	=	0.0 in
Overhang Height	=	0.0 in
Overhang Extension	=	0.0 in
Fin Separation	=	0.0 in
Fin Extension	=	0.0 in

Exposure	Gross Area (sqft)	Glass Area (sqft)
E Wall	0.0	0.0
S Wall	162.5	9.0
W Wall	162.5	9.0
N Wall	0.0	0.0
Roof (Hor)	156.0	0.0

****

ZONE DESCRIPTION FOR Northwest Zone

Prepared By : Software Systems Network 04-02-91

Block Load Program v2.01 Page 1 of 1

****

TABLE 1. GENERAL ZONE DATA

ZONE NAME = Northwest Zone

GENERAL ZONE DATA		**PEOPLE**	
Floor Area :	156.0 sqft	sqft/person :	156.0 sqft/per
Building Weight:	M	Unocc Diversity:	0 %
Exposures :	N, E, S, W	Activity Level :	Office Work
Are Multiple Wall, Roof, or Glass Types Used ?	N	Sensible Gain :	245.0 BTU/hr/per
		Latent Gain :	205.0 BTU/hr/per
		MISCELLANEOUS LOADS	
		Sensible :	0 BTU/hr
No. Partitions :	0	Latent :	0 BTU/hr
LIGHTING		Unocc Diversity:	0 %
W/sqft :	1.25 W/sqft	**INFILTRATION**	
Unocc Diversity:	10 %	Cooling :	0.05 CFM/sqft
Wattage Mult. :	1.00	Heating :	0.10 CFM/sqft
Fixture Type :	Recessed, Vented	**SLAB**	
OTHER ELECTRIC		Area :	156 sqft
W/sqft :	0.25 W/sqft	Perimeter :	12 ft
Unocc Diversity:	0 %	Depth :	0.00 ft

****

TABLE 2. WALL, ROOF AND GLASS DATA

	WALL	ROOF	GLASS	
U-Value (BTU/hr/sqft/F)	0.120	0.080	U-Value	0.550
Weight (lb/sqft)	30	L	Glass Factor	0.63
Color	M	D	Int. Shades ?	Y

EXTERNAL SHADING DATA		Overhang Height =	0.0 in
Window Height =	8.0 ft	Overhang Extension =	0.0 in
Window Width =	4.0 ft	Fin Separation =	0.0 in
Reveal Depth =	0.0 in	Fin Extension =	0.0 in

Exposure	Gross Area (sqft)	Glass Area (sqft)
E Wall	0.0	0.0
S Wall	0.0	0.0
W Wall	162.5	9.0
N Wall	162.5	9.0
Roof (Hor)	156.0	0.0

****

****

TABLE 1. GENERAL ZONE DATA

ZONE NAME = Interior Zone

GENERAL ZONE DATA		**PEOPLE**	
Floor Area :	6250.0 sqft	sqft/person :	125.0 sqft/per
Building Weight:	M	Unocc Diversity:	0 %
Exposures :	N, E, S, W	Activity Level :	Office Work
Are Multiple Wall, Roof, or Glass Types Used ?	N	Sensible Gain :	245.0 BTU/hr/per
		Latent Gain :	205.0 BTU/hr/per
		MISCELLANEOUS LOADS	
		Sensible :	0 BTU/hr
No. Partitions :	0	Latent :	0 BTU/hr
LIGHTING		Unocc Diversity:	0 %
W/sqft :	2.00 W/sqft	**INFILTRATION**	
Unocc Diversity:	10 %	Cooling :	0.00 CFM/sqft
Wattage Mult. :	1.00	Heating :	0.00 CFM/sqft
Fixture Type :	Recessed, Vented	**SLAB**	
OTHER ELECTRIC		Area :	0 sqft
W/sqft :	0.25 W/sqft	Perimeter :	0 ft
Unocc Diversity:	0 %	Depth :	0.00 ft

****

TABLE 2. WALL, ROOF AND GLASS DATA

	WALL	ROOF	GLASS	
U-Value (BTU/hr/sqft/F)	0.120	0.080	U-Value	0.550
Weight (lb/sqft)	30	L	Glass Factor	0.63
Color	M	D	Int. Shades ?	Y

EXTERNAL SHADING DATA		Overhang Height =	0.0 in
Window Height =	8.0 ft	Overhang Extension =	0.0 in
Window Width =	4.0 ft	Fin Separation =	0.0 in
Reveal Depth =	0.0 in	Fin Extension =	0.0 in

Exposure	Gross Area (sqft)	Glass Area (sqft)
E Wall	0.0	0.0
S Wall	0.0	0.0
W Wall	0.0	0.0
N Wall	0.0	0.0
Roof (Hor)	6,250.0	0.0

****

HVAC SYSTEM DATA FOR DX-VAV Example Bldg.

Prepared By: Software Systems Network 04-02-91
Block Load v2.01 Page 1 of 1

****

Table 1. HVAC SYSTEM DESCRIPTION

System Type	: Clg & Warm Air Htg	THERMOSTAT SETPOINTS	
System Start	: 700	Cooling (Occ)	: 75.0 F
Duration	: 12 hrs	Cooling (Unocc)	: 85.0 F
		Heating	: 70.0 F
SIZING SPECIFICATIONS			
Supply	: 57.0 F	FACTORS	
Ventilation	: 15.00 CFM/person	Coil Bypass	: 0.100
Exhaust	: 0 %	Safety (Sens)	: 0 %
		Safety (Latent)	: 0 %
		Heating Safety	: 0 %
FAN			
Configuration	: Draw-Thru	RETURN AIR PLENUM	: Y
Static Pressure	: 2.50 in.wg.	% Roof Load	: 70
		% Lighting Load	: 30
		% Wall Load	: 15

Table 2. SYSTEM ZONING INFORMATION

System Arrangement: All zones served by a common air handler
Total Zones Selected: 9

Selected Zones:

1 North Zone
2 East Zone
3 South Zone
4 West Zone
5 Northeast Zone
6 Southeast Zone
7 Southwest Zone
8 Northwest Zone
9 Interior Zone

```
                SYSTEM SIZING SUMMARY
System Name : DX-VAV Example Bldg.                               04-02-91
Location    : Cincinnati, Ohio                            Block Load v2.01
Prepared By : Software Systems Network                     Page   1 of   2
**************************************************************************

TABLE 1. SIZING DATA -- COOLING
--------------------------------------------------------------------------
Total coil load      =   246,899 BTU/hr  Load occurs        @    July 1500
Sensible coil load =   201,207 BTU/hr  Outdoor Db/Wb      = 92.0/ 73.0 F
Total zone sensible=   115,060 BTU/hr  Coil Conditions:
Supply temperature =      57.0 F        Entering Db/Wb     = 86.7/ 67.2 F
Supply air (actual)=     6,084 CFM      Leaving Db/Wb      = 55.2/ 53.5 F
Supply air (std)   =     5,919 CFM      Apparatus dewpoint=       51.7 F
Ventilation air    =     1,230 CFM      Bypass factor      =      0.100
Direct exhaust air =         0 CFM     Resulting zone RH   =       49.1 %
Reheat required    =         0 BTU/hr

 Floor area (sqft)      =    11,248  Total coil load      =    20.57 Ton
 Overall U-value        =     0.102  Sensible coil load   =    16.77 Ton
 Vent air CFM/sqft      =      0.11  SQFT/Ton             =   546.69
 Vent air CFM/person    =     15.00  Cooling BTU/hr/sqft  =    21.95
                                     Cooling CFM/sqft     =     0.54
--------------------------------------------------------------------------

TABLE 2. SIZING DATA -- HEATING
--------------------------------------------------------------------------
Heating coil load   =   265,640 BTU/hr    Heating BTU/hr/sqft =      23.62
Ventilation load    =    89,168 BTU/hr    Heating CFM/sqft    =       0.54
Total zone load     =   176,472 BTU/hr    Floor area (sqft)   =     11,248
Ventilation airflow=     1,230 CFM        Overall U-value     =      0.102
Supply airflow      =     6,084 CFM       Vent air CFM/sqft   =       0.11
                                          Vent air CFM/person =      15.00
--------------------------------------------------------------------------

TABLE 3. INPUT DATA -- WEATHER
--------------------------------------------------------------------------
City            = Cincinnati                Summer dry-bulb     =  92.0 F
State           = Ohio                      Coincident wet-bulb=  73.0 F
Data Source     = ASHRAE 1%                 Daily Range         =  21.0 F
Latitude        =   39.2 deg.               Winter dry-bulb     =   1.0 F
Elevation       =  761.0 ft                 Atmos. Clear. Num. =  0.95
--------------------------------------------------------------------------

TABLE 4. INPUT DATA -- HVAC SYSTEM
--------------------------------------------------------------------------
System Type         : Clg & Warm Air Htg      THERMOSTAT SETPOINTS
System Start        :       700                  Cooling (Occ)    :   75.0 F
Duration            :        12 hrs              Cooling (Unocc) :   85.0 F
                                                 Heating          :   70.0 F
SIZING SPECIFICATIONS                          FACTORS
  Supply            :      57.0 F                Coil Bypass      :  0.100
  Ventilation       :     15.00 CFM/person       Safety (Sens)    :      0 %
  Exhaust           :         0 %                Safety (Latent) :      0 %
                                                 Heating Safety   :      0 %
FAN                                            RETURN AIR PLENUM :      Y
  Configuration     : Draw-Thru                  % Roof Load      :     70
  Static Pressure :        2.50 in.              % Lighting Load :     30
                                                 % Wall Load      :     15
--------------------------------------------------------------------------
```

TABLE 5. TOP TEN COOLING COIL LOADS

	Time	Sensible Ton	Total Ton		Time	Sensible Ton	Total Ton
1)	July/1500	16.77	20.57	6)	Aug/1600	16.35	20.13
2)	Aug/1500	16.65	20.45	7)	July/1700	15.96	19.73
3)	July/1600	16.56	20.35	8)	July/1300	15.76	19.54
4)	July/1400	16.50	20.28	9)	Aug/1300	15.65	19.44
5)	Aug/1400	16.42	20.20	10)	Aug/1700	15.58	19.34

TABLE 6. ZONE SIZING DATA

Zone Name	Maximum Cooling Sensible (BTU/hr)	Design Airflow Rate (CFM)	Design Time	Maximum Heating Load (BTU/hr)	Design Flow Rate (CFM)
North Zone	16,508	873	@July 1500	42,378	-
East Zone	8,230	435	@July 1000	16,954	-
South Zone	22,810	1,206	@Sept 1400	42,378	-
West Zone	10,267	543	@July 1700	16,954	-
Northeast Zone	2,331	123	@July 1400	5,827	-
Southeast Zone	2,847	151	@ Aug 1400	5,827	-
Southwest Zone	3,237	171	@ Aug 1600	5,827	-
Northwest Zone	2,952	156	@July 1700	5,827	-
Interior Zone	51,533	2,725	@July 1500	34,500	-
	Total :	6,383			

DETAILED SYSTEM LOAD REPORT

System Name : DX-VAV Example Bldg. 04-02-91
Location : Cincinnati, Ohio Block Load v2.01
Prepared By : Software Systems Network Page 1 of 1

****

TABLE 1. LOAD COMPONENT SUMMARY for July 1500 (92.0/ 73.0 F)

Load Component	Details	Design Cooling Loads Sensible (BTU/hr)	Design Cooling Loads Latent (BTU/hr)	Design Heating (BTU/hr)
Solar Loads	324 sqft	11,060	-	-
Wall Transmission	5,526 sqft	11,520	-	45,755
Roof Transmission	11,248 sqft	18,843	-	62,089
Glass Transmission	324 sqft	2,368	-	12,296
Skylight Transmission	0 sqft	0	-	0
Partitions	0 sqft	0	-	0
Lighting	1.76 W/sqft	41,407	-	-
Other Electric	0.25 W/sqft	8,674	-	-
People	82 people	15,595	16,811	-
Infiltration		4,463	4,877	36,231
Miscellaneous		0	0	-
Slab	4,998 sqft	-	-	20,101
Pulldown/Warm-up		1,129	-	-
Safety Factor	0/ 0/ 0 %	0	0	0
Total Zone Loads		115,060	21,687	176,472
Ventilation Load	1,230 CFM	8,564	24,005	89,168
Supply Fan Load	6,084 CFM	11,275	-	-
Plenum Load Thru Wall	15 %	2,033	-	-
Plenum Load Thru Roof	70 %	43,966	-	-
Plenum Load - Lights	30 %	20,309	-	-
Total Coil Loads		201,207	45,692	265,640

TABLE 2. WALL AND GLASS BREAKDOWN

Component		Total Net Area (sqft)	Cooling Transmission (BTU/hr)	Cooling Solar Load (BTU/hr)	Heating Transmission (BTU/hr)
Walls :	NE	0	0	-	0
	E	921	2,699	-	7,626
	SE	0	0	-	0
	S	1,842	4,664	-	15,252
	SW	0	0	-	0
	W	921	1,619	-	7,626
	NW	0	0	-	0
	N	1,842	2,538	-	15,252
Glass :	NE	0	0	0	0
	E	54	395	1,355	2,049
	SE	0	0	0	0
	S	108	789	3,066	4,099
	SW	0	0	0	0
	W	54	395	4,742	2,049
	NW	0	0	0	0
	N	108	789	1,897	4,099

Moduline® Selection (Analysis of Data) — The printout shown below presents an analysis of the preceding data.

Zone Name	Total Airflow Rate (CFM)	Total Cooling Load (Btu/hr)	Total Area (sq ft)	# of Rooms	Load per Room (Btu/hr)	Room Air (CFM)
North Zone	873	16,508	1,562	10	1,651	87
East Zone	435	8,230	625	4	2,058	109
South Zone	1,206	22,810	1,562	10	2,281	121
West Zone	543	10,267	625	4	2,567	136
Northeast Zone	123	2,331	156	1	2,331	123
Southeast Zone	151	2,847	156	1	2,847	151
Southwest Zone	171	3,237	156	1	3,237	171
Northwest Zone	156	2,952	156	1	2,952	156
Interior Zone	2,725	51,533	6,250	1	51,533	2,725

Heating — Heat must be provided in a building to offset losses through the perimeter walls, windows, and roof. In the interior spaces the heat gain from lights and people will in many cases be enough to cause a cooling load even in winter.

The two most commonly used heating systems are these:

- Baseboard
- Overhead air

Baseboard has been used historically in the North because it is effective in overcoming the downdraft from windows, particularly with the large single pane windows used in the past.

Now, with improvements in the building thermal envelope due to better materials and construction methods, overhead air heating is a viable and attractive alternative.

Overhead air heating, when properly applied, can handle all requirements except the severe cases in which the wall U values and temperature differences are large.

Overhead air heating is the method which will be considered for these procedures.

OVERHEAD AIR HEATING — Two basic forms of overhead heating are used with Moduline cooling systems:

- Separate duct heating
- Changeover Moduline heating/cooling

Separate Duct Heating — A simple type of overhead air heating system for use with a Moduline cooling system consists of a series of ceiling outlets, placed around the perimeter of the building close to the outside wall, which blow warm air outward and/or downward to floor level. The outlets are connected by a simple duct system to an electric (or hot water) heating-only fan coil unit located above the ceiling. (See Fig. 5.) A minimum of one fan coil unit per exposure is used for each story of the building. The fan coil unit draws air from the ceiling plenum and distributes it to the building perimeter by means of a separate duct system. This type of heating system operates at constant volume.

The separate duct heating approach allows heat to blanket the outside wall, eliminating the transmission of heat through the outside wall and permits the Moduline cooling units to be located in the best arrangement for cooling distribution. Control interlock between separate system heating and Moduline cooling is outlined in the Control Applications section, on page 44.

The 35BD heating slot boot diffuser (Fig. 6) is specifically designed for this heating approach and will provide excellent distribution of the hot air necessary to offset the load.

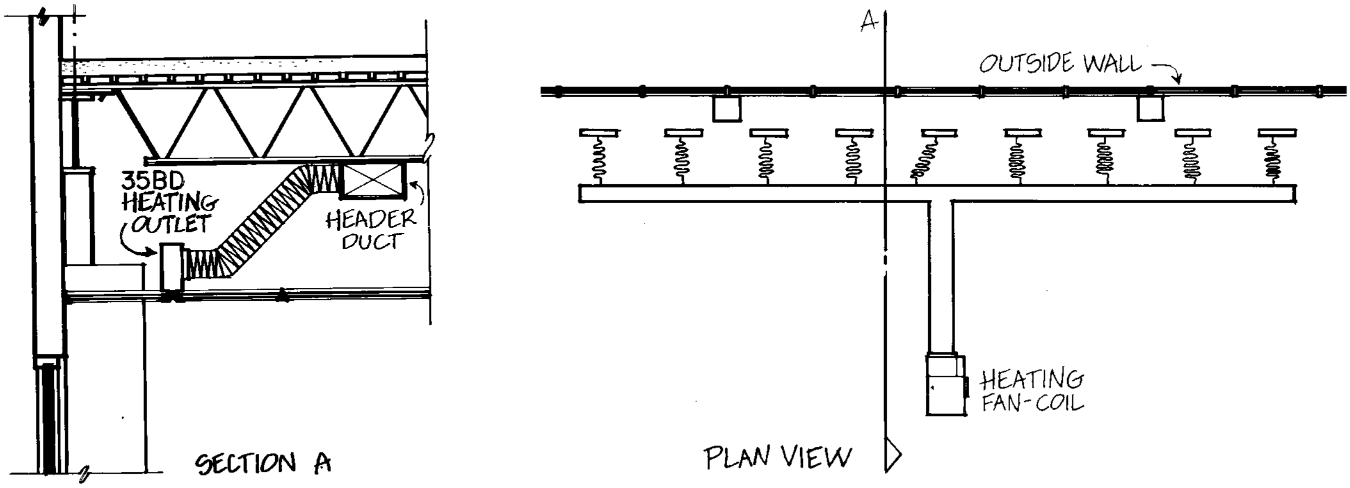
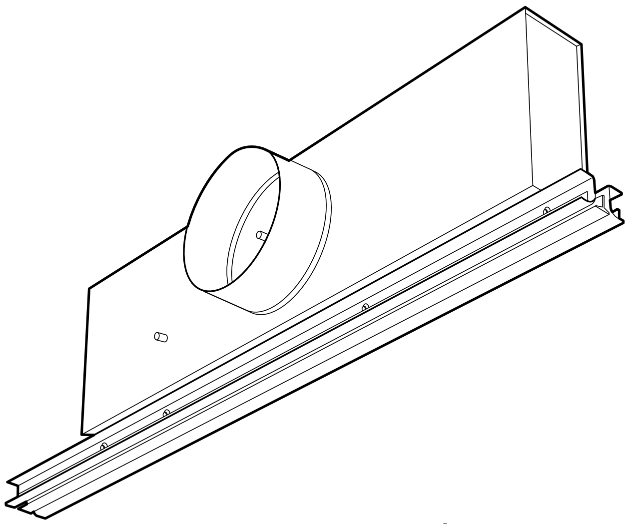
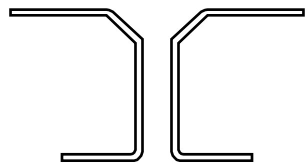


Fig. 5 — Separate Duct Heating System





Performance Heating — Downblow Slot

NOMINAL LENGTH (ft)	2			4		
TYPE DIFFUSER	Cfm	Placement (in.)		Cfm	Placement (in.)	
		Min	Max		Min	Max
Heating Slot Boot Diffuser	20-70	12	24	25-120	12	24

NOTES:
1. Minimum and maximum show distance diffuser should be located from perimeter wall in inches.
2. For optimum performance of the diffuser, the air temperature should be held between 90 and 115 F.

Fig. 6 — 35BD Heating Slot Boot Diffuser

Changeover Moduline® Heating/Cooling — Both hot air and cold air distribution are possible with a Moduline system. The Moduline unit uses a director diffuser which, sensing the duct temperature of the supply air, directs the air towards or away from the perimeter wall. (Fig. 7.)

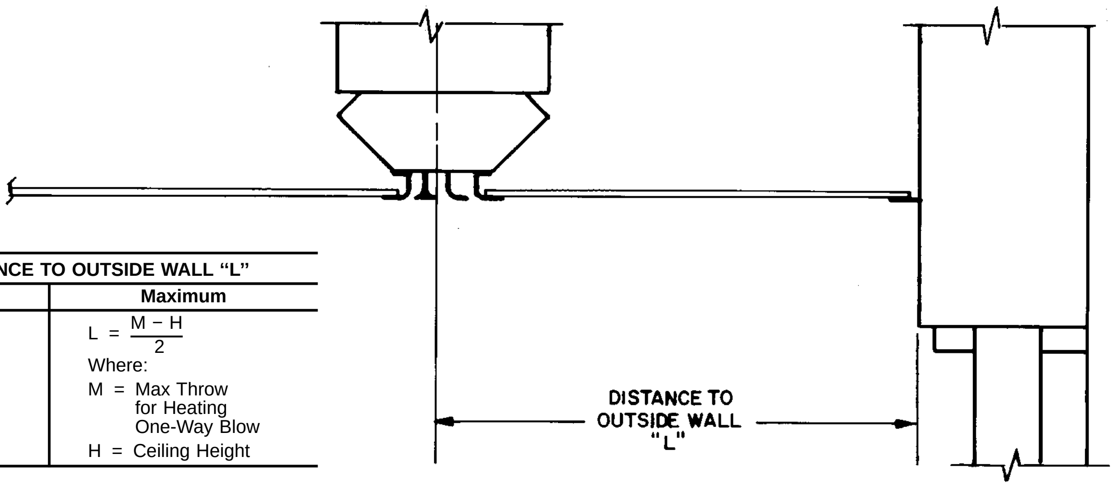
The Moduline location for heating and cooling requires the unit to be a specific distance from the outside wall in order to produce satisfactory distribution of the hot air. The recommended location is shown in Fig. 8.



With hot air in the duct, all discharge air is directed towards the perimeter wall to offset the transmission.

With cold air in the duct, the discharge is two-way blow — both into the room and towards the wall.

Fig. 7 — Director Diffuser



DISTANCE TO OUTSIDE WALL "L"	
Minimum	**Maximum**
2.5 Ft	$L = \frac{M - H}{2}$ Where: M = Max Throw for Heating One-Way Blow H = Ceiling Height

Fig. 8 — Recommended Location for Changeover Moduline® Heating/Cooling

Additional Guidelines for Heating — In addition to downblow slot boot diffusers and Moduline director diffusers, round nozzles spaced along the perimeter wall will also provide satisfactory overhead heating distribution. Some guidance for outlet use are shown in Tables 1 and 2.

Moduline heating and cooling is less flexible than separate duct system heating with Moduline cooling because:

- Moduline heating/cooling is a changeover system requiring complete replacement of the cooling duct supply air with heated air, making zone control difficult.
- Moduline location is a compromise between obtaining outside wall coverage with hot air and good cooling distribution.

Thus, separate duct heating can provide heat for a given exposure without materially affecting the building cooling system. The heating outlets and Moduline terminals can be located in the most efficient air distribution places of the conditioned space.

Table 1 — Optimum Outlet Discharge

DIFFUSER SLOTS	VELOCITY (Fpm)	TEMPERATURE (F)
Downblow slots	500 to 1250	90 to 115
Round nozzles	900 to 1800	90 to 125
One-way blow slots	600 to 2200	80 to 105
Director Diffusers	800 to 2200	90 to 105

Table 2 — Location Guidelines

DIFFUSER STYLE	MINIMUM DISTANCE (ft)*	MAXIMUM DISTANCE (ft)*
Round Nozzles and Downblow Slots	1.0	2.0
One-Way Blow Slots	0.5	L†
Director Diffusers	2.5	L†

*Feet away from outside wall.
†See Fig. 8.

TERMINAL SELECTION AND LAYOUT

Introduction — Selecting the terminals and making a layout is one of the most important steps in the design process. This is where you use your knowledge to lay out the job at a low cost and still give your client a satisfactory job.

There are 4 items which must be considered when selecting an air terminal:

- air volume (Cfm) per terminal — a function of 1) the desired sound level in the space, and 2) cost
- layout — a function of 1) the proper room air motion and 2) physical spacing
- unit combinations and run-out duct
- controller location

Definitions — Following are definitions of terms used when discussing the layout of a Moduline system.

Moduline units are arranged as single units or as units in an air series.

SINGLE UNIT — A single unit is connected to the supply duct and supplies conditioned air to a space or part of a space. Fig. 9.

AIR SERIES — Units in air series are connected unit-to-unit or with interconnecting ductwork and the supply air for all units enters the first unit in the series. Fig. 10.

MASTER UNIT — A Moduline unit with controller, alone or in air series, is a master unit. Fig. 11.

SLAVE UNIT — A unit in air series, controlled by another unit (master unit) is a slave unit. Fig. 11.

CONTROLS — System-powered controls are installed at the jobsite and consist of the components shown below:

Constant Volume — Filter and volume controller.

Variable Volume, Diffuser Thermostat — Filter, volume controller, thermostat with aspirator.

Variable Volume, Wall Thermostat — Filter, volume controller, wall thermostat.

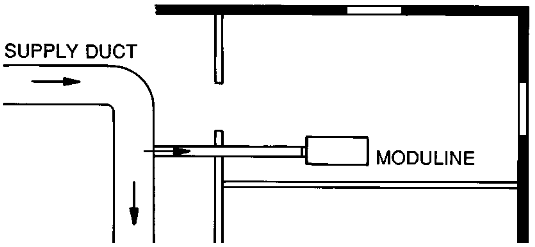


Fig. 9 — Single Moduline® Unit Connected to Supply Duct

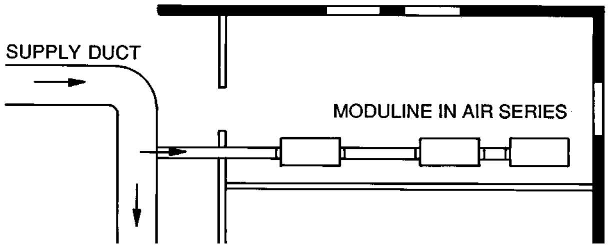


Fig. 10 — Moduline Units in Air Series

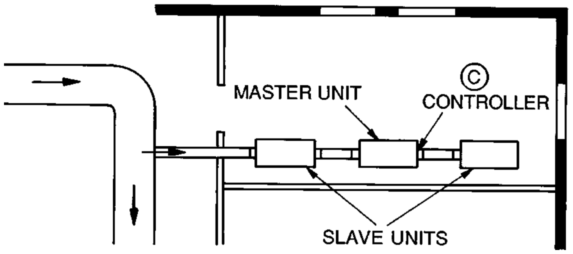


Fig. 11 — Master Unit and Slave Units

CONTROL END — The control end of a Moduline® unit is the end containing a control block at the end plate of the valve section of the unit. (Fig. 12.) The end of the unit opposite the control end contains a blank block. The control end of the Moduline unit is at the longer of the diffuser projections from the plenum. In Fig. 13, the longer projection, B, is the control end.

The filter, volume controller, and diffuser-mounted thermostat are applied to the control end of a master unit.

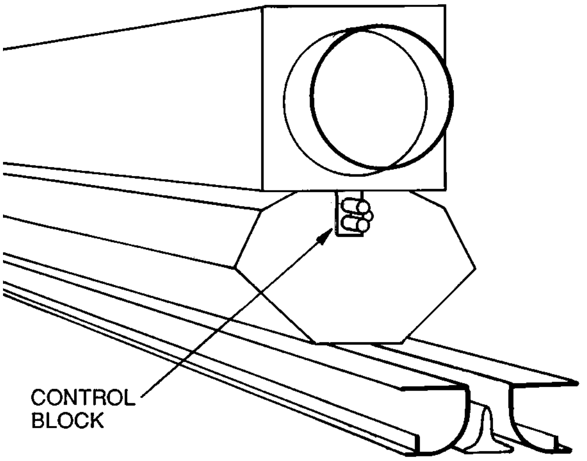


Fig. 12 — Control Block

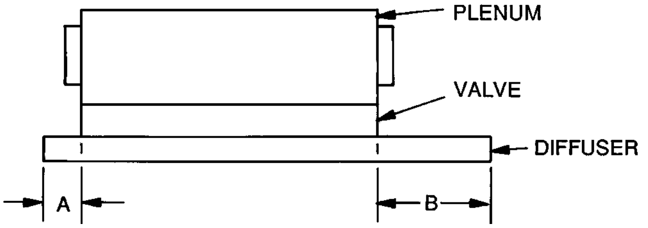


Fig. 13 — Control End of Unit

Step 1 — Determine Air Volume (Cfm) Per Terminal — Before you can start making a layout, you must know the required air volumes (cfm).

Use the cfm per zone you obtained from the cooling load calculation and, using Table 3, Recommended Maximum Cfm Per Terminal, decide on the number of terminals you will need in each zone.

Cost dictates that the fewest number of Moduline units be used consistent with good design. The maximum cfm per unit that can be used (to keep the total number of units down) is mainly a function of maximum acceptable sound level.

Perimeter zones with glass in the east, west, and south building zones have peaks of rather short duration (i.e. loads vary widely during the course of the day and year). Therefore, a higher sound level can be tolerated for these short peaks.

As a result, slightly higher maximum cfm per unit is allowed as compared to interior zones or the north perimeter, which have relatively constant loads.

The maximum cfm per unit also is affected by the desired sound level in the room and the type of use of the space.

For example, an executive office uses low sound levels but the furnishings generally absorb more sound so the allowable cfm/unit is only slightly lower than other types of rooms.

Table 3 — Recommended Maximum Cfm Per Terminal

TYPE OF SPACE USE		MODULINE UNITS					
		37HS1		37HS2		37HS4	
		East West and South	Interior and North	East West and South	Interior and North	East West and South	Interior and North
General Office		110	95	220	190	400	350
Private Office	With Carpet	100	90	200	180	330	300
	With Tile	90	80	180	160	300	270
Executive Office		85	75	170	150	280	250

Step 2 — Lay Out Terminals

LOCATE UNITS IN T-BAR GRID — In making a layout, begin with a plan view of the ceiling. Normally, the ceiling grid and the lighting is done first and the diffuser plan must fit the layout.

The center of the room is the ideal location, but where that space has been reserved for lighting, the Moduline diffuser has enough flexibility to provide good distribution when not centered in the room.

For a two-way blow diffuser, anywhere from the ¼ point to the ¼ point (wall to wall) is usually suitable. Outside of the ¼ points, a one-way blow diffuser may be needed. Use two-way blow diffuser wherever possible and one-way blow only when really necessary. (See Fig. 14.)

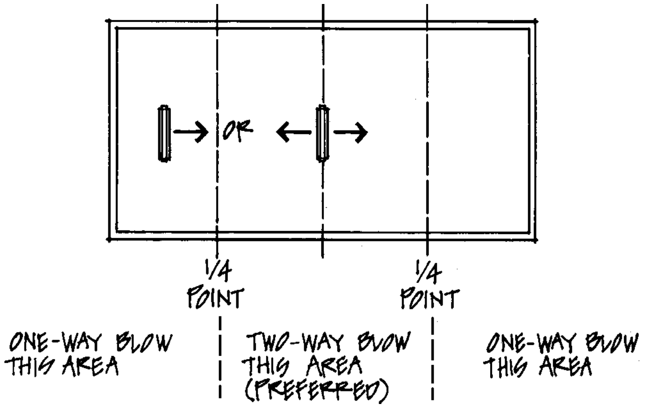


Fig. 14 — Diffuser Locations for Preferred 2-Way or One-Way Blow

Most jobs use a 2- x 4-ft grid T-Bar ceiling with 2- x 4-ft or 2- x 2 ft tiles.

The first consideration in making a layout is to place the terminals as economically as possible in the grid, which means locating the terminals perpendicular to the main tees.

Main tees (the ones with hangers) are 4 ft on center (normally) and the cross tees are spaced 2 ft apart between the mains to make up a 2- x 4-ft T-bar grid. Additional trim tees may be used to divide the ceiling into a 2- x 2-ft grid.

The Moduline units use mounting brackets and hang from (run perpendicular to) the main tees. While the units can be installed anywhere between mains, the most common location is on the center line of the cross tee (replaces the cross tee). The next most common location is half way between cross tees. See Fig. 15.

While less desirable, the units can be run parallel to the main tees. Unless absolutely necessary the units should not replace the main tee because this means the main tee must be cut. A location halfway between the mains is common and in this case additional hangers are required to the upper plenum of the unit or to the cross tee near the unit.

Special units are available for many other types of ceilings.

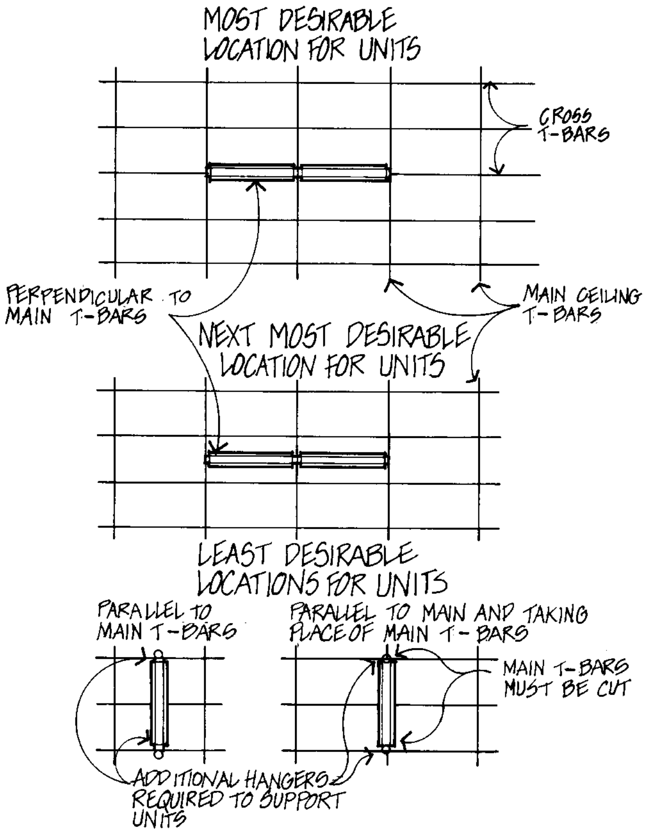


Fig. 15 — Terminal Location

EVALUATE THE THROW OF MODULINE® UNITS IN POSSIBLE LOCATIONS — Check minimum throw for 2-way blow diffuser near walls and all one-way blow diffusers.

Exceeding maximum throw is almost never a problem. A 2-way blow unit covers 50 ft at nominal cfm.

In perimeter rooms, if 2-way blow units are off center, favor the exterior wall if possible.

Generally, one-way blow diffusers should blow away from the nearest wall.

Air throw data in Tables 4 and 5 for the Moduline® air terminals provides the suggested minimum and maximum coverages the units can handle in a typical installation while maintaining the desired room conditions.

The optimum air throw values given in the table are distances from the unit centerline to the outside wall or nearest obstruction (wall, light fixture, or opposing air stream).

When given a choice, *always put diffusers in line with each other, not blowing at each other.* If diffusers must be placed so they are blowing at each other, the minimum throw must be checked. *Do not put units closer together than minimum allows.* Down-drafts caused by going below minimum will bother room occupants. (Fig. 16)

Moduline® units can be placed fairly close to a wall or partition. This is because the down-draft follows the wall (stays close to the wall) and doesn't bother the room occupant. If furniture is placed against the wall near a Moduline unit, it causes the air to be deflected causing drafts. The problem can often be solved by moving the furniture 6 in. or so away from the wall.

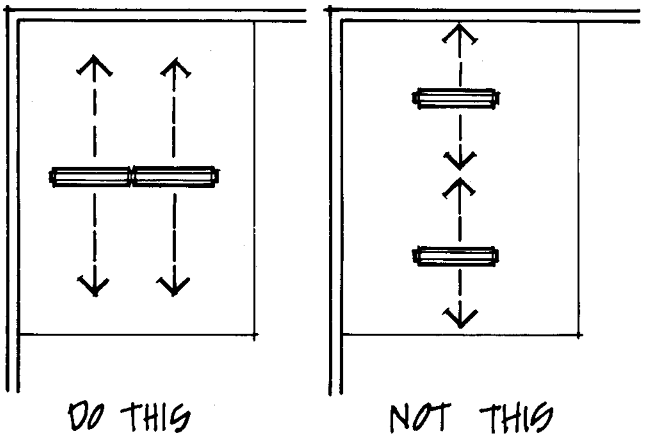


Fig. 16 — Locate Units to Prevent Down-Drafts

Table 4 — Air Throw Data — 1-Way and 2-Way Blow, 2-Slot Diffusers

37HS1 UNIT AIRFLOW (Cfm)	OPTIMUM AIR THROW (ft)			
	1-Way Blow		2-Way Blow	
	Min	Max	Min	Max
40	2.0	7.0	2.0	5.0
50	4.0	9.0	3.0	6.0
60	7.5	12.0	3.5	7.5
70	8.0	15.0	4.0	9.0
80	9.0	18.0	4.5	10.5
90	10.0	20.0	5.0	11.5
100	11.0	22.0	6.0	13.0
110	12.0	24.0	7.0	15.0

37HS2 UNIT AIRFLOW (Cfm)	OPTIMUM AIR THROW (ft)			
	1-Way Blow		2-Way Blow	
	Min	Max	Min	Max
80	2.0	7.0	2.0	5.0
100	4.0	9.0	3.0	6.0
120	7.5	12.0	3.5	7.5
140	8.0	15.0	4.0	9.0
160	9.0	18.0	4.5	10.5
180	10.0	20.0	5.0	11.5
200	11.0	22.0	6.0	13.0
220	12.0	24.0	7.0	15.0

37HS4 UNIT AIRFLOW (Cfm)	OPTIMUM AIR THROW (ft)			
	1-Way Blow		2-Way Blow	
	Min	Max	Min	Max
160	8.5	16.0	5.0	7.0
200	10.0	20.0	6.0	10.0
250	11.0	21.0	7.0	13.0
300	12.0	22.0	8.0	17.0
350	14.0	23.0	9.0	19.0
400	15.0	25.0	10.0	21.0
440	17.0	29.0	13.0	24.0

Table 5 — Air Throw Data — 2-Way and 1-Way Director, 3-Slot Diffusers

37HS1 UNIT AIRFLOW (Cfm)	OPTIMUM AIR THROW (ft)			
	Heating		Cooling	
	1-Way Blow		2-Way Blow	
	Min	Max	Min	Max
40	2.0	7.0	2.0	5.0
50	4.0	9.0	3.0	6.0
60	7.5	12.0	3.5	7.5
70	8.0	15.0	4.0	9.0
80	9.0	18.0	4.5	10.5
90	10.0	20.0	5.0	11.5
100	11.0	22.0	6.0	13.0
110	12.0	24.0	7.0	15.0

37HS2 UNIT AIRFLOW (Cfm)	OPTIMUM AIR THROW (ft)			
	Heating		Cooling	
	1-Way Blow		2-Way Blow	
	Min	Max	Min	Max
80	2.0	7.0	2.0	5.0
100	4.0	9.0	3.0	6.0
120	7.5	12.0	3.5	7.5
140	8.0	15.0	4.0	9.0
160	9.0	18.0	4.5	10.5
180	10.0	20.0	5.0	11.5
200	11.0	22.0	6.0	13.0
220	12.0	24.0	7.0	15.0

37HS4 UNIT AIRFLOW (Cfm)	OPTIMUM AIR THROW (ft)			
	Heating		Cooling	
	1-Way Blow		2-Way Blow	
	Min	Max	Min	Max
160	8.5	16.0	5.0	7.0
200	10.0	20.0	6.0	10.0
250	11.0	21.0	7.0	13.0
300	12.0	22.0	8.0	17.0
350	14.0	23.0	9.0	19.0
400	15.0	25.0	10.0	21.0
440	17.0	29.0	13.0	24.0

NOTES:
1. Minimum air throw refers to the distance from the diffuser where the air velocity is 150 fpm. In maximum air throw, this velocity has dropped to 50 rpm.
2. Data is based on an area with a 9-ft ceiling. For higher ceilings, values may be reduced by one foot for each foot of height increase. For specific installations, minimum values can be reduced if properly qualified. Values are dependent on cfm only and are not affected by duct pressure.

STAGGER SPACING — A frequently used layout method is to stagger the units. This arrangement gives good coverage, solves the problem of drafts when units blow at each other, and is low cost. It also gives good flexibility for future partition changes. (Fig. 17.)

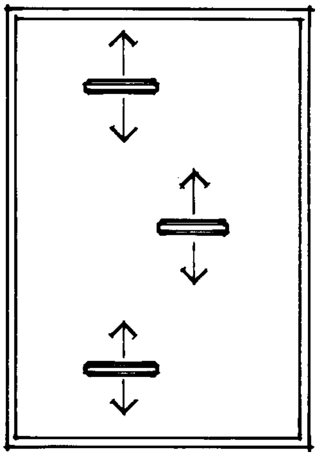


Fig. 17 — Staggered Units

MAXIMUM UNIT SPACING — Interior zones use less air, as low as 0.4 to 0.6 cfm per sq ft. Using the large capacity 37HS4 unit at 250 to 350 cfm each may cause units to be too widely separated. This results in poor coverage and poor air distribution.

A good solution is to use a larger number of lower capacity 37HS2 units at 150 to 190 cfm each.

The maximum distance between units parallel to each other (blowing at each other) can and should be fairly great, 25 to 45 ft. (See Tables 4 and 5.) But the maximum distance between the ends of the units in the same row must be more limited for good coverage.

The unit will effectively cover a strip whose width is 3 to 4 times the unit's length. A 4-ft unit would therefore cover an area whose width is 12 to 16 ft (maximum). See Fig. 18.

The high induction ratio of the Moduline® diffuser keeps total room air motion up to acceptable levels when the cfm per sq ft is low.

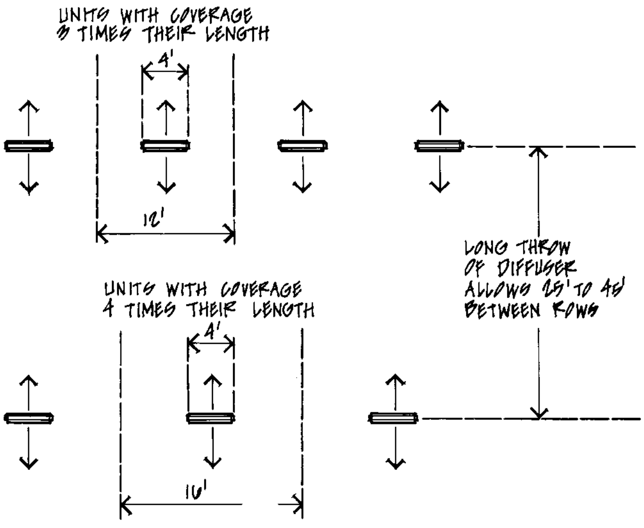


Fig. 18 — Unit Spacing

Step 3 — Consider Unit Combinations And Run-Out Duct

— When the preliminary office layout is complete, the trunk or main duct can be laid on the floor plan. We are now ready for positioning the units in the space according to the load calculations and the design of the run-out ducts.

The zone load calculation provides the cfm requirements for each space. Using those requirements and the ceiling layout, the unit location and run-out can be determined. Figure 19 shows a single Moduline unit located on the grid line in the approximate center of the space. Figure 20 shows multiple units in an air series located in similar fashion.

RECOMMENDED UNIT COMBINATIONS — Tables 6-8 list the recommended combinations of Moduline terminals. Each model (size) of Moduline terminal is shown in combinations of 2, 3, 4 and 5 plenum sizes. To illustrate the use of the tables, consider the 37HS2 for a space requiring 550 cfm. Three units in air series will provide the capacity. (Note that 550 cfm is below the max cfm limit of 660 shown in Table 7.) Six combinations of 37HS2 units are available; all will produce a good installation. However, some factors influence the choice:

If it is desirable to have common plenum sizes throughout the space, the choice will be three 9 x 9-in. plenums.

The lowest inlet velocities will result in the least variance of discharge cfm among the 3 units on one control. If this is a consideration, the choice would be three 11 x 11-in. plenums.

The lowest cost choice would be 9- x 9-in., 9- x 9-in., and 7- x 7-inches.

If the requirement of the space is for maximum cfm from the unit combination, one of the larger plenum combinations would be favored.

Conversely, a conservative design with small cfm per unit can use the smaller plenum sizes.

The selection of plenum sizes will not affect the sound level of the space; there is no measurable difference in the recommended plenum combinations.

NOTE: The listing of recommended air series combinations does not indicate that one controller will always handle the combination; in some cases, a second controller may be required. Refer to Determine Controller Location section, page 37.

Table 9 provides an overall limitation on cfm in the inlet collar of units in air series.

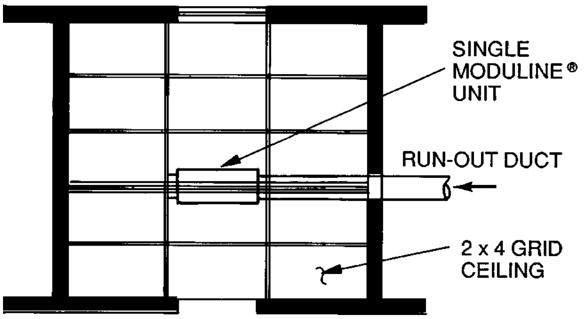


Fig. 19 — Run-Out Duct for Single Moduline® Unit

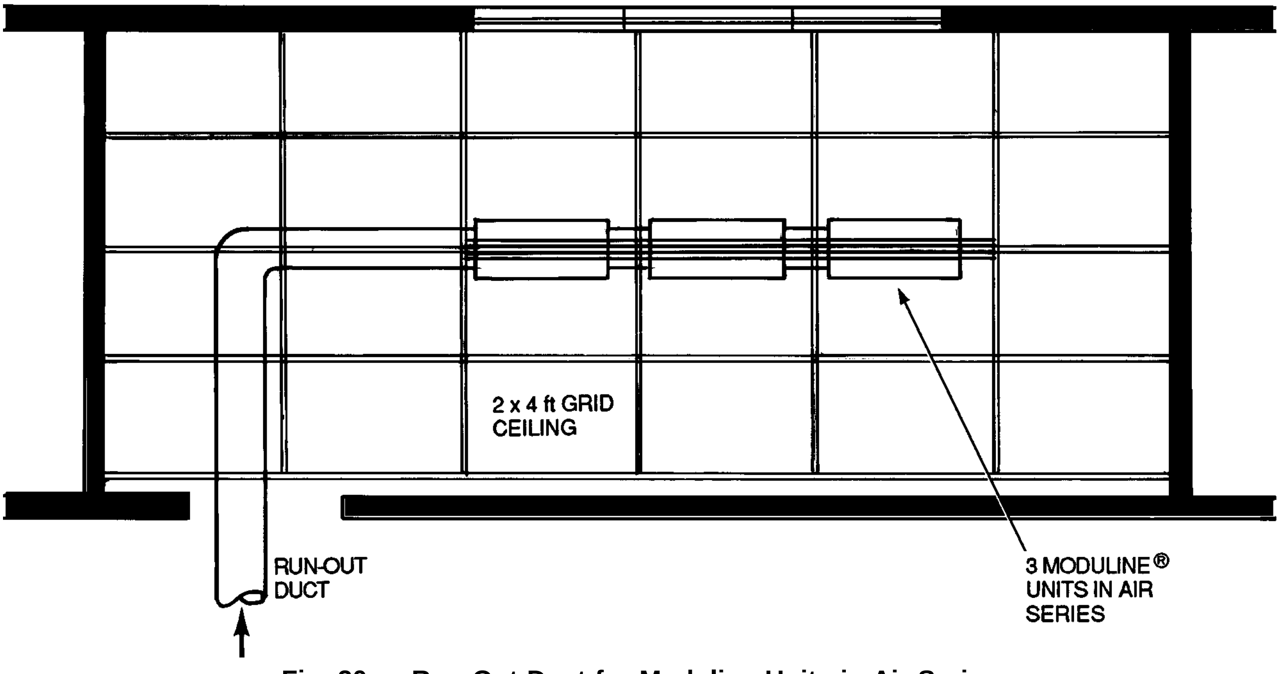


Fig. 20 — Run-Out Duct for Moduline Units in Air Series

Table 6 — 37HS1 Units in Air Series

NO. OF UNITS (MASTER AND SLAVE)	MAX CFM	SUPPLY DUCT DIAM (IN.)	DUCT AND PLENUM (IN.)/AVAILABLE COMBINATIONS
1	110	4	4 — 5 x 7
1	110	6	6 — 7 x 7
1	110	8	8 — 9 x 9
1	110	10	10 — 11 x 11
2	220	6	6 — 7 x 7 — 6 — 7 x 7
2	220	8	8 — 9 x 9 — 6 — 7 x 7
2	220	8	8 — 9 x 9 — 8 — 9 x 9
2	220	10	10 — 11 x 11 — 8 — 9 x 9
2	220	10	10 — 11 x 11 — 10 — 11 x 11
3	330	6	6 — 7 x 7 — 6 — 7 x 7 — 6 — 7 x 7
3	330	8	8 — 9 x 9 — 6 — 7 x 7 — 6 — 7 x 7
3	330	8	8 — 9 x 9 — 8 — 9 x 9 — 6 — 7 x 7
3	330	10	10 — 11 x 11 — 8 — 9 x 9 — 6 — 7 x 7
3	330	10	10 — 11 x 11 — 8 — 9 x 9 — 8 — 9 x 9
3	330	10	10 — 11 x 11 — 10 — 11 x 11 — 8 — 9 x 9
3	330	10	10 — 11 x 11 — 10 — 11 x 11 — 10 — 11 x 11

Table 6 — 37HS1 Units in Air Series (cont)

NO. OF UNITS (MASTER AND SLAVE)	MAX CFM	SUPPLY DUCT DIAM (IN.)	DUCT AND PLENUM (IN.)/AVAILABLE COMBINATIONS
4	400	6	6 · 7 x 7 · 6 · 7 x 7 · 6 · 7 x 7 · 6 · 7 x 7
4	440	8	8 · 9 x 9 · 6 · 7 x 7 · 6 · 7 x 7 · 6 · 7 x 7
4	440	8	8 · 9 x 9 · 8 · 9 x 9 · 6 · 7 x 7 · 6 · 7 x 7
4	440	8	8 · 9 x 9 · 8 · 9 x 9 · 8 · 9 x 9 · 6 · 7 x 7
4	440	10	10 · 11 x 11 · 10 · 11 x 11 · 8 · 9 x 9 · 6 · 7 x 7
4	440	10	10 · 11 x 11 · 8 · 9 x 9 · 8 · 9 x 9 · 8 · 9 x 9
4	440	10	10 · 11 x 11 · 10 · 11 x 11 · 8 · 9 x 9 · 8 · 9 x 9
4	440	10	10 · 11 x 11 · 10 · 11 x 11 · 10 · 11 x 11 · 8 · 9 x 9
4	440	10	10 · 11 x 11 · 10 · 11 x 11 · 10 · 11 x 11 · 10 · 11 x 11
5	550	8	8 · 9 x 9 · 6 · 7 x 7 · 6 · 7 x 7 · 6 · 7 x 7 · 6 · 7 x 7
5	550	8	8 · 9 x 9 · 8 · 9 x 9 · 6 · 7 x 7 · 6 · 7 x 7 · 6 · 7 x 7
5	550	10	10 · 11 x 11 · 8 · 9 x 9 · 8 · 9 x 9 · 6 · 7 x 7 · 6 · 7 x 7
5	550	10	10 · 11 x 11 · 8 · 9 x 9 · 8 · 9 x 9 · 8 · 9 x 9 · 6 · 7 x 7
5	550	10	10 · 11 x 11 · 10 · 11 x 11 · 10 · 11 x 11 · 8 · 9 x 9 · 6 · 7 x 7
5	550	10	10 · 11 x 11 · 10 · 11 x 11 · 8 · 9 x 9 · 8 · 9 x 9 · 8 · 9 x 9
5	550	10	10 · 11 x 11 · 10 · 11 x 11 · 10 · 11 x 11 · 8 · 9 x 9 · 8 · 9 x 9
5	550	10	10 · 11 x 11 · 10 · 11 x 11 · 10 · 11 x 11 · 10 · 11 x 11 · 8 · 9 x 9
5	550	10	10 · 11 x 11 · 10 · 11 x 11 · 10 · 11 x 11 · 10 · 11 x 11 · 10 · 11 x 11

Table 7 — 37HS2 Units in Air Series

NO. OF UNITS (MASTER AND SLAVE)	MAX CFM	SUPPLY DUCT DIAM (IN.)	DUCT AND PLENUM (IN.)/AVAILABLE COMBINATIONS
1	220	6	6, 7 x 7
1	220	8	8, 9 x 9
1	220	10	10, 11 x 11
2	440	8	8, 9 x 9, 6, 7 x 7
2	440	8	8, 9 x 9, 8, 9 x 9
2	440	10	10, 11 x 11, 8, 9 x 9
2	440	10	10, 11 x 11, 10, 11 x 11
3	660	8	8, 9 x 9, 8, 9 x 9, 6, 7 x 7
3	660	10	10, 11 x 11, 8, 9 x 9, 6, 7 x 7
3	660	8	8, 9 x 9, 8, 9 x 9, 8, 9 x 9
3	660	10	10, 11 x 11, 8, 9 x 9, 8, 9 x 9
3	660	10	10, 11 x 11, 10, 11 x 11, 8, 9 x 9
3	660	10	10, 11 x 11, 10, 11 x 11, 10, 11 x 11
4	800	8	8, 9 x 9, 8, 9 x 9, 8, 9 x 9, 6, 7 x 7
4	880	10	10, 11 x 11, 8, 9 x 9, 8, 9 x 9, 6, 7 x 7
4	880	10	10, 11 x 11, 10, 11 x 11, 8, 9 x 9, 6, 7 x 7
4	880	10	10, 11 x 11, 8, 9 x 9, 8, 9 x 9, 8, 9 x 9
4	880	10	10, 11 x 11, 10, 11 x 11, 8, 9 x 9, 8, 9 x 9
4	880	10	10, 11 x 11, 10, 11 x 11, 10, 11 x 11, 8, 9 x 9

Table 7 — 37HS2 Units in Air Series (cont)

NO. OF UNITS (MASTER AND SLAVE)	MAX CFM	SUPPLY DUCT DIAM (IN.)	DUCT AND PLENUM (IN.)/AVAILABLE COMBINATIONS
4	880	10	10, 11 x 11, 10, 11 x 11, 10, 11 x 11, 10, 11 x 11
5	1100	10	10, 11 x 11, 8, 9 x 9, 8, 9 x 9, 8, 9 x 9, 6, 7 x 7
5	1100	10	10, 11 x 11, 10, 11 x 11, 8, 9 x 9, 8, 9 x 9, 6, 7 x 7
5	1100	10	10, 11 x 11, 10, 11 x 11, 10, 11 x 11, 8, 9 x 9, 6, 7 x 7
5	1100	10	10, 11 x 11, 10, 11 x 11, 8, 9 x 9, 8, 9 x 9, 8, 9 x 9
5	1100	10	10, 11 x 11, 10, 11 x 11, 10, 11 x 11, 8, 9 x 9, 8, 9 x 9
5	1100	10	10, 11 x 11, 10, 11 x 11, 10, 11 x 11, 10, 11 x 11, 8, 9 x 9
5	1100	10	10, 11 x 11, 10, 11 x 11, 10, 11 x 11, 10, 11 x 11, 10, 11 x 11

Table 8 — 37HS4 Units in Air Series

NO. OF UNITS (MASTER AND SLAVE)	MAX CFM	SUPPLY DUCT DIAM (IN.)	DUCT AND PLENUM (IN.)/AVAILABLE COMBINATIONS
1	440	8	8, 9 x 9
1	440	10	10, 11 x 11
1	440	12	12, 13 x 13
2	880	10	10, 11 x 11, 8, 9 x 9
2	880	10	10, 11 x 11, 10, 11 x 11
2	880	12	12, 13 x 13, 10, 11 x 11
2	880	12	12, 13 x 13, 12, 13 x 13

Table 8 — 37HS4 Units in Air Series (cont)

NO. OF UNITS (MASTER AND SLAVE)	MAX CFM	SUPPLY DUCT DIAM (IN.)	DUCT AND PLENUM (IN.)/AVAILABLE COMBINATIONS									
3	1100	10	10	11 x 11	10	11 x 11	8	9 x 9				
3	1320	12	12	13 x 13	10	11 x 11	8	9 x 9				
3	1100	10	10	11 x 11	10	11 x 11	10	11 x 11				
3	1320	12	12	13 x 13	10	11 x 11	10	11 x 11				
3	1320	12	12	13 x 13	12	13 x 13	10	11 x 11				
3	1320	12	12	13 x 13	12	13 x 13	12	13 x 13				
4	1600	12	12	13 x13	12	13x13	10	11 x 11	8	9 x 9		
4	1600	12	12	13 x 13	10	11 x 11	10	11 x 11	8	9 x 9		
4	1600	12	12	13 x 13	10	11 x 11	10	11 x 11	10	11 x 11		
4	1600	12	12	13 x 13	12	13 x 13	10	11 x 11	10	11 x 11		
4	1600	12	12	13 x 13	12	13 x 13	12	13 x 13	10	11 x 11		
4	1600	12	12	13 x 13	12	13 x 13	12	13 x 13	12	13 x 13		
5	1600	12	12	13 x 13	12	13 x 13	12	13 x 13	10	11 x 11	8	9 x 9
5	1600	12	12	13 x 13	12	13 x 13	10	11 x 11	10	11 x 11	8	9 x 9
5	1600	12	12	13 x 13	12	13 x 13	10	11 x 11	10	11 x 11	10	11 x 11
5	1600	12	12	13 x 13	12	13 x 13	12	13 x 13	10	11 x 11	10	11 x 11
5	1600	12	12	13 x 13	12	13 x 13	12	13 x 13	12	13 x 13	10	11 x 11
5	1600	12	12	13 x 13	12	13 x 13	12	13 x 13	12	13 x 13	12	13 x13

Table 9 — Maximum Cfm Through the Inlet Collar of a Single Unit or of Units in Air Series

MODEL	PLENUM SIZE (in.)	INLET COLLAR DIAM (in.)	MAXIMUM TOTAL AIRFLOW (Cfm)
37HS1	5 x 7	4	110
	7 x 7	6	400
	9 x 9	8	800
	11 x 11	10	1100
37HS2	7 x 7	6	400
	9 x 9	8	800
	11 x 11	10	1100
37HS4	9 x 9	8	800
	11 x 11	10	1100
	13 x 13	12	1600

In general, units in an air series should not be of mixed sizes (cfm capacities). If units of different capacities are used, a controller must be applied for each size unit. For example, an application for 800 cfm using different capacity units, as shown in Fig. 21, is acceptable only with multiple controls. This arrangement, although not preferred, can be used if care is taken to use the necessary controllers. In this case, 3 controllers are required. However, the best installation for an 800 cfm (nominal cfm total) would be one in which all the units are the same size. (Fig. 22.) In this case, a single controller can be used in the space.

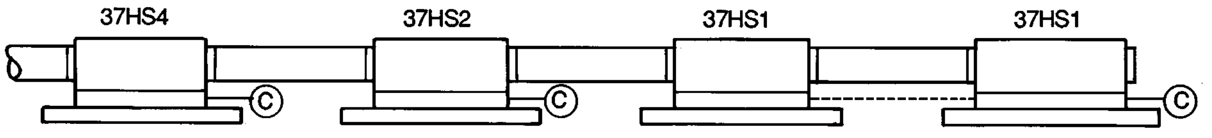


Fig. 21 — Air Series of Units with Different Capacities

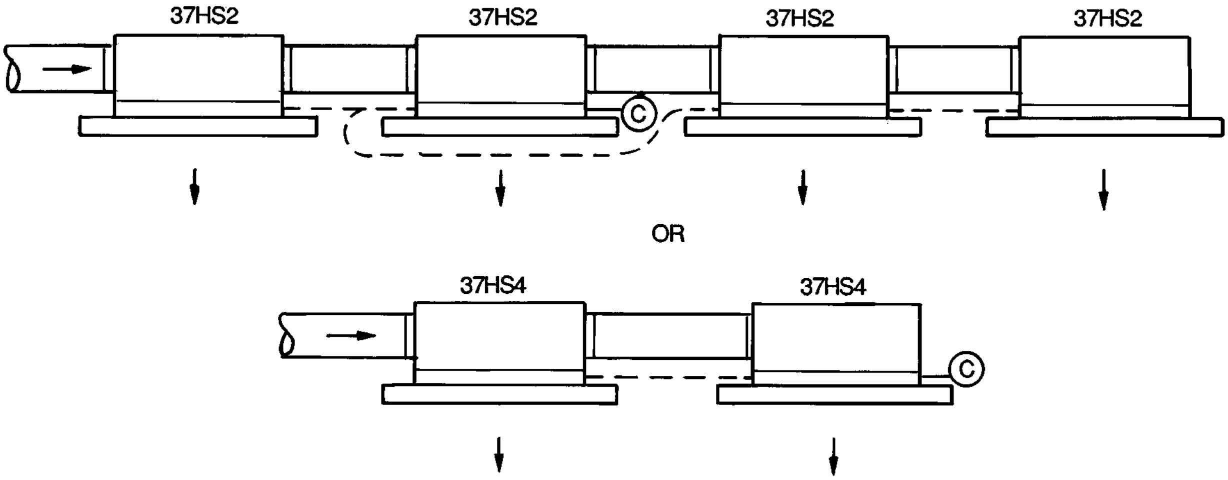


Fig. 22 — Air Series of Units of the Same Size and Capacity

FLEX DUCT IN AIR SERIES — Flexible duct is often used in air series to connect Moduline® units. In calculating pressure requirements for units in air series, use the following guidelines:

1. For close-coupled units (either continuous diffuser or units in adjoining ceiling modules) where the flexible duct used is 6 to 8 in. in length, add 0.1 in. wg to unit requirement for minimum static pressure at control unit (Table 10).

   For example, consider three 37HS2 units in air series, in adjoining modules, with 200 cfm per unit (Fig. 23). The minimum static pressure for multiple units is equal to 0.75 in. wg (from Table 10). Adding 0.1 in. wg for flexible duct, the total pressure downstream of run-out duct equals 0.85 in. wg.

2. For units in air series with extended flexible duct lengths, add ΔP from Table 11.

   For example, consider four 37HS2 units in air series, 200 cfm per unit (Fig. 24). The units are in alternate series modules; 8-in. duct; 9- x 9-in. plenum. The minimum static pressure for multiple units is equal to 0.75 in. wg. Three lengths of flex duct at 4.5 ft equal 13.5 ft. From Table 11, read with 8-in. duct diam, ΔP is equal to 0.16 in. wg for each 10 ft. of flex duct. Therefore, for 13.5 ft, ΔP is equal to 0.16 + 0.06 in. wg. The total ΔP downstream of run-out duct is equal to 0.75 + 0.22 = 0.97 in. wg.

3. Flexible duct, unsupported, tends to sag; this deflection increases the pressure drop. Whenever possible, support the duct with wire between connections. Sagging will increase the ΔP as much as 0.06 in. wg in a 10-ft length; therefore rigid duct is recommended for lengths greater than 5.5 ft.

4. The use of flexible duct in air series run-out when 90 degree turns are required will also add ΔP. Table 12 provides the additional pressure drop.

   For example, refer to Fig. 25. The ''straight'' line ΔP is equal to 0.97 in. wg. If a bend is added to the run-out, the total pressure drop becomes:

   $$0.97 + 0.16 = 1.13 \text{ in. wg.}$$

Table 10 — Minimum Static Pressure at Control (Master) Unit — Units with System-Powered Controls and Standard Diffusers

AIRFLOW (Cfm)	37HS1		37HS2	37HS4
	PLENUM SIZE (in.)			
	5 x 7	7 x 7 9 x 9 11 x 11	7 x 7 9 x 9 11 x 11	9 x 9 11 x 11 13 x 13
	Minimum Static Pressure (in. wg)			
40 50 60 70	0.75	0.75	N/A	N/A
80 90 100	0.75	0.75	0.75	N/A
110	0.90	0.90	0.75	N/A
120 140	N/A	N/A	0.75	N/A
160 180 200	N/A	N/A	0.75	0.75
220	N/A	N/A	0.90	0.75
240 280 320 360 400	N/A	N/A	N/A	0.75
440	N/A	N/A	N/A	0.90

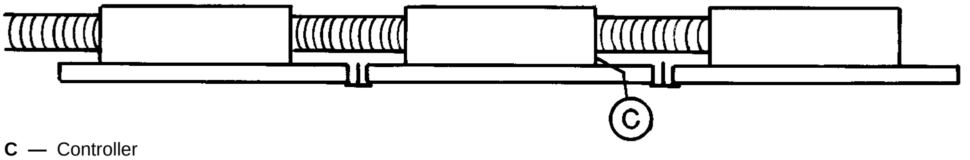
N/A — Not Applicable
NOTE: Maximum inlet pressure — 3.0 in. wg.

Table 11 — Additional ΔP for Extended Lengths of Flexible Duct

FLEX DUCT DIAM (in.)	TOTAL CFM IN AIR SERIES	ADDITIONAL ΔP PER 10 FT FLEX DUCT (in. wg)
6	400	0.2
8	800	0.16
10	1100	0.1
12	1600	0.07

Table 12 — Additional ΔP for Flexible Duct with 90-Degree Bend

FLEX DUCT DIAM (in.)	TOTAL CFM IN AIR SERIES	RADIUS OF BEND (in.)	ADDITIONAL ΔP FOR 90° BEND IN FLEXIBLE DUCT (in. wg)
6	400	18	0.26
8	800	24	0.16
10	1100	30	0.08
12	1600	36	0.04



C — Controller

Fig. 23 — Three 37HS2 Moduline® Units in Adjoining Modules

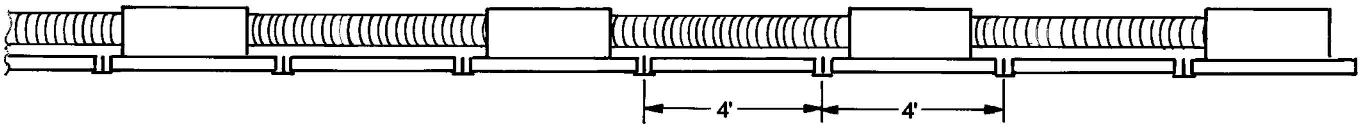


Fig. 24 — Four 37HS2 Moduline Units in Alternate Series Modules

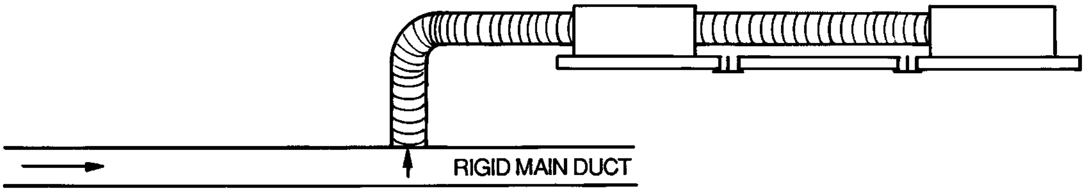


Fig. 25 — Flexible Duct Used with 90-Degree Bend

Step 4 — Determine Controller Location — The final step in the terminal selection and layout process is to decide where the controllers will be placed.

The temperature control zones in the building will be determined by the final partition layout. Before the final partition layout has been determined, you must install enough controllers to meet job requirement; the controllers can then be relocated when the tenant layout is finished.

One of the main features of Moduline controls is that controller locations can be changed quickly and easily at any time.

Another main feature of Moduline controls is that more than one unit can be controlled from a single thermostat. In large interior zones the ‘‘master’’ unit (the one with the thermostat) can be hooked up with control tubing to control several ‘‘slaves’’. Table 13 shows the maximum number of units that can be controlled by one controller.

Table 13 — Maximum Number of Units in an Air Series on One Controller

MODEL	PLENUM SIZE (in.) FIRST UNIT IN AIR SERIES*	NUMBER OF UNITS ON ONE CONTROLLER				
		Single Unit	Units in Air Series			
			2	3	4	5
37HS1	5 x 7†	X	—	—	—	—
	7 x 7	X	X	X	X	—
	9 x 9	X	X	X	X	X
	11 x 11	X	X	X	X	X
37HS2	7 x 7	X	—	—	—	—
	9 x 9	X	X	X	X	—
	11 x 11	X	X	X	X	—
37HS4	9 x 9	X	—	—	—	—
	11 x 11	X	X	X	X	—
	13 x 13	X	X	X	X	—

*See Tables 6-8 for recommended combinations of units in air series.
†The 37HS1 unit with 5 x 7 size plenum is available with blank end only; multiple units of this size would not be used on one control.

NOTE: The conditions stated in Table 9 must be included in evaluations for selecting the number of units in an air series.

GUIDELINES FOR CONTROLLER LOCATION

1. A master unit is mounted in the ceiling so that the air intake is on the end of the unit opposite the end with the control block and controller. (Fig. 26.)
2. A slave unit can receive air from either end of the unit. Either end can be the inlet, assuming the inlet collar is the same size as the connecting unit. At the same time, it is good practice to place the ‘‘control’’ end of a slave unit downstream as shown in Fig. 26. Should the slave unit be later converted to a master unit, the unit would be in its correct configuration for control installation.
3. The volume controller for a single unit should be located on the end of the unit opposite the inlet end. (Fig. 27.)

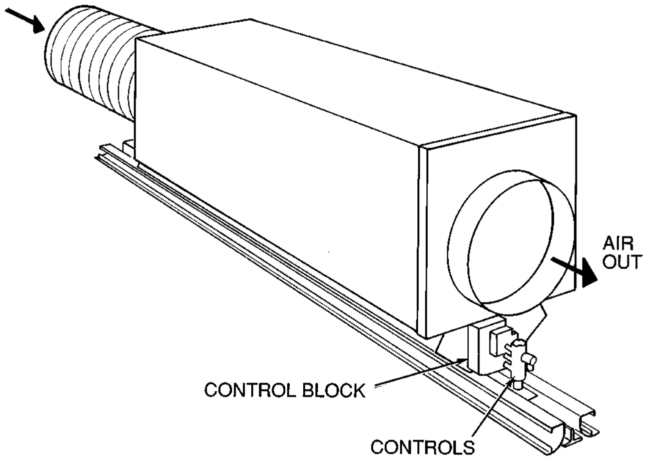
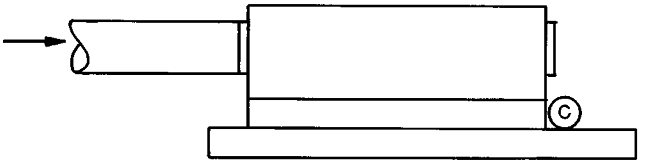


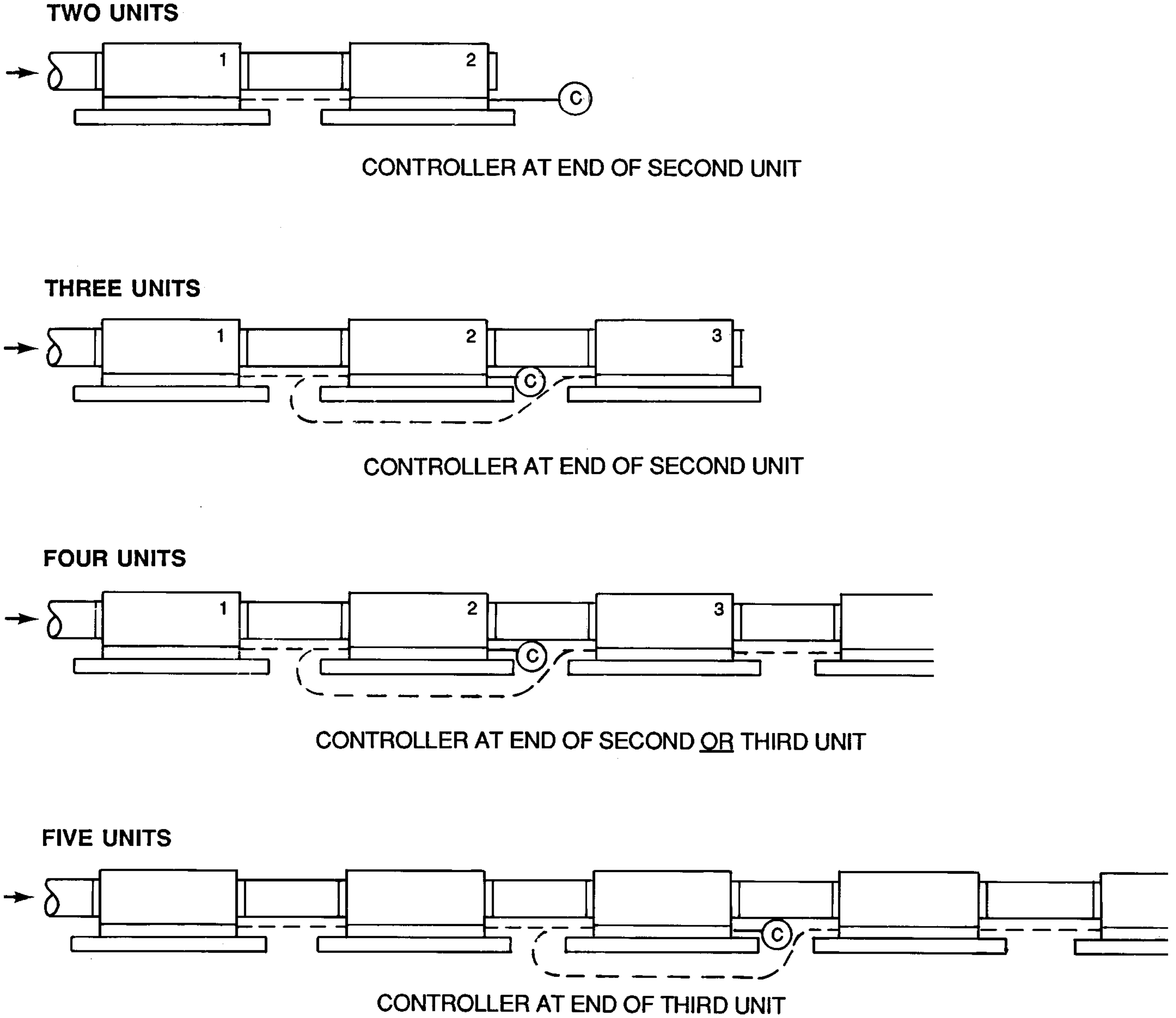
Fig. 26 — Air Intake on Master Unit

4. The controller for units in an air series should be located as shown in Fig. 28.
5. Volume controllers for units in an air series must be connected from master to slave units in the same air series; they must not be connected to units in a different air series from that of the master unit. See examples shown in Fig. 29 and 30.
6. To connect slave units with control tubing, use the end bellows fittings only; do not attempt to use the 0.25 molded connection on the filter. See Fig. 31 for examples of control tubing connections.



C — Controller

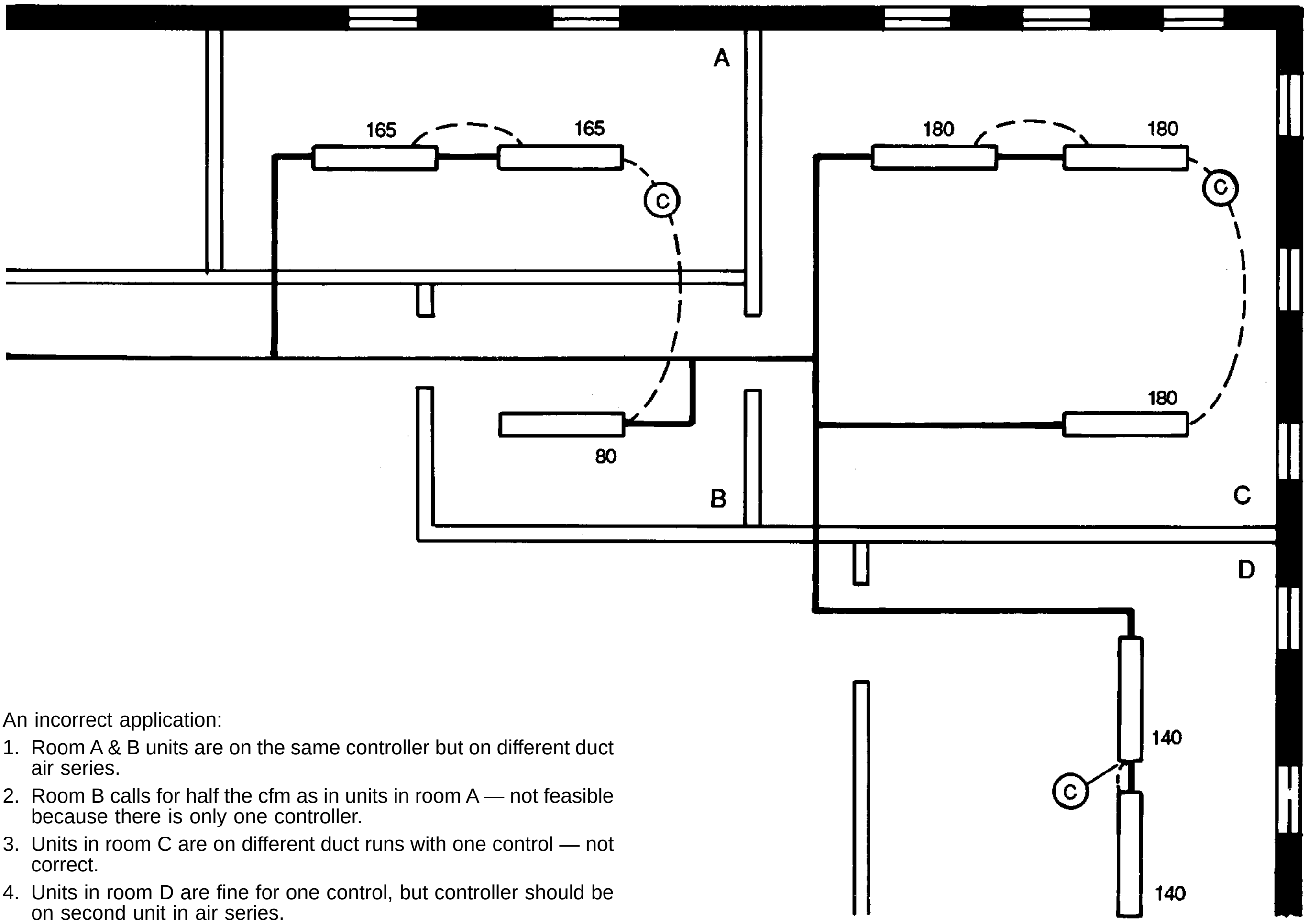
Fig. 27 — Location of Volume Controller on Single Unit



C — Controller

Fig. 28 — Location of Volume Controller on Units in an Air Series

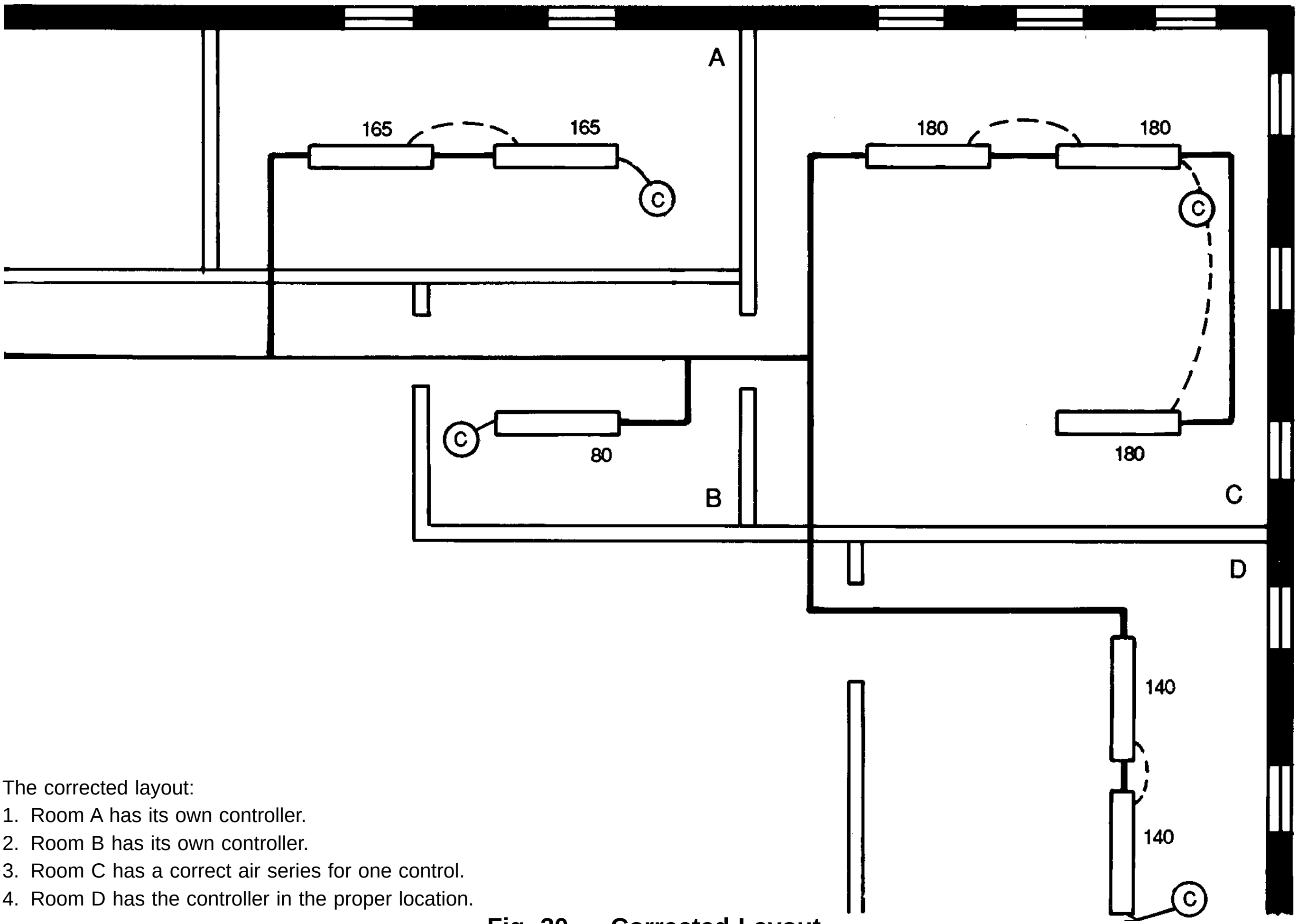
EXAMPLES OF GUIDELINE USE — Figure 29 shows an incorrect application. Figure 30 shows the corrected layout.



An incorrect application:

1. Room A & B units are on the same controller but on different duct air series.
2. Room B calls for half the cfm as in units in room A — not feasible because there is only one controller.
3. Units in room C are on different duct runs with one control — not correct.
4. Units in room D are fine for one control, but controller should be on second unit in air series.

Fig. 29 — Incorrect Layout of Moduline® Units with Controls



The corrected layout:
1. Room A has its own controller.
2. Room B has its own controller.
3. Room C has a correct air series for one control.
4. Room D has the controller in the proper location.

Fig. 30 — Corrected Layout

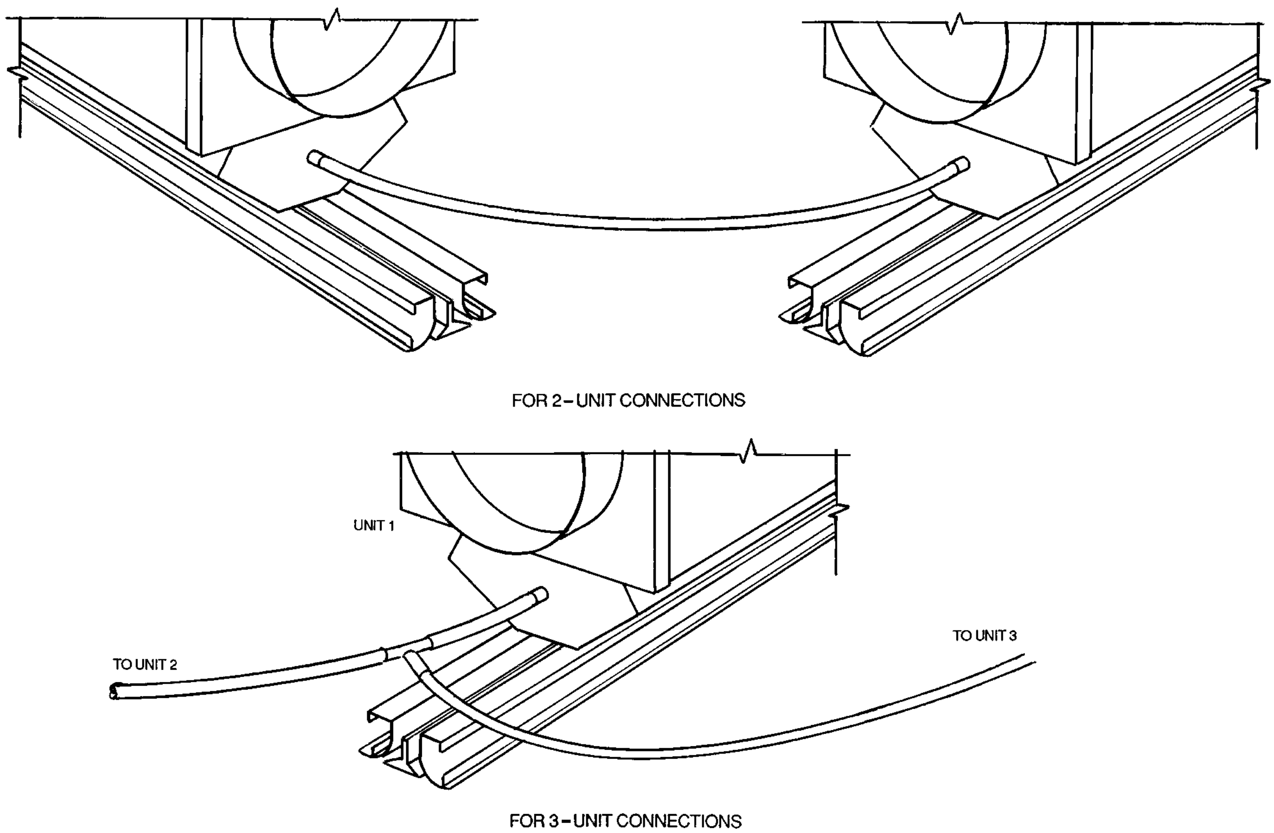


Fig. 31 — Control Tubing Connection

Final Layout — After these 4 steps are complete, you are ready to make a final layout.

The final layout should show not only the number and location of the Moduline units, but also:

- the round duct size connected to the unit
- the controller location
- the control tube layout for connecting the master unit (with thermostat) to all its slaves
- the cfm for the master unit (all slaves will be the same cfm and need not be indicated)
- the model number of the unit to be used

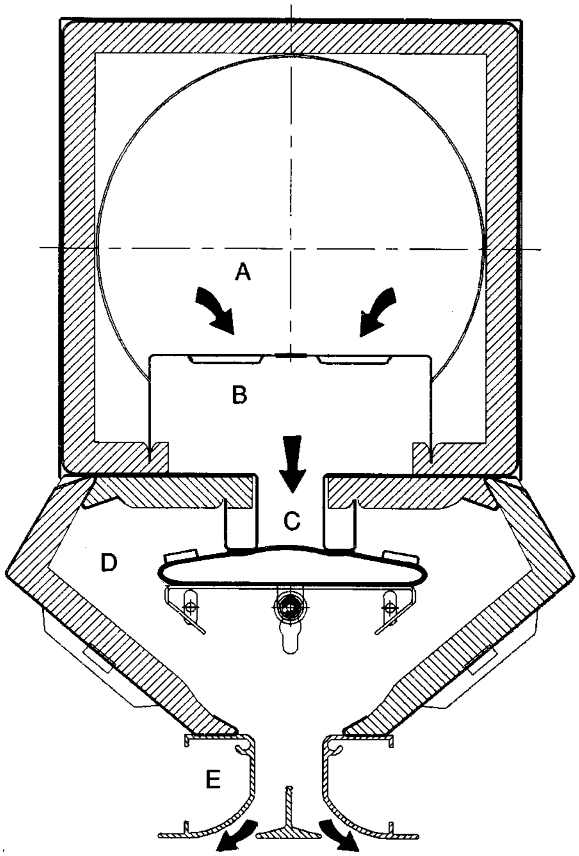
THE MODULINE® VALVE

The Moduline Control Concept — The 37HS Moduline system-powered control concept is based on using the building's primary air supply as a source of energy. The distribution duct pressure provides energy to operate the controls that modulate the flow of air through the unit. The heart of this system is a bellows-operated unit air valve, which is positioned by varying the pressure of the air in the bellows relative to the supply air pressure in the duct. As the pressure in the bellows approaches the pressure in the supply duct, the unit air valve opening is reduced, finally closing completely when the pressures are equal.

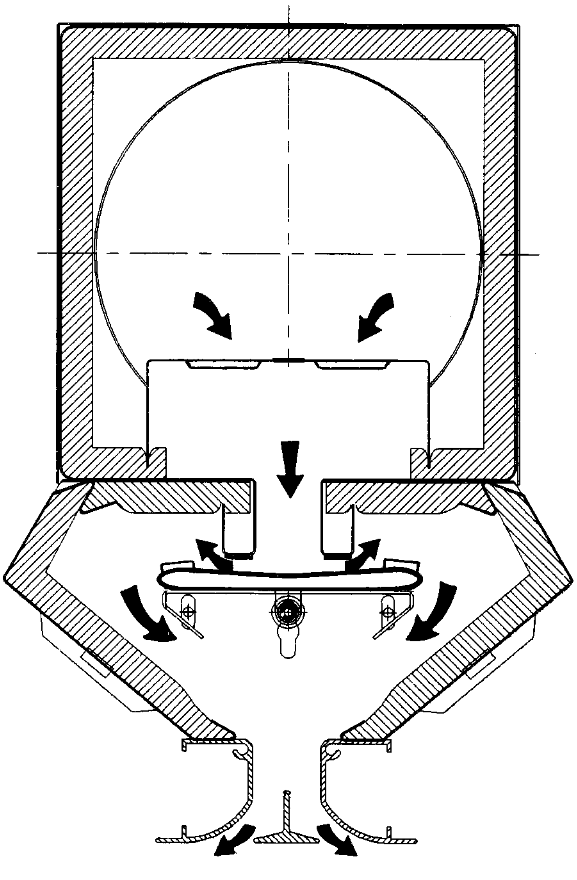
Figure 32 shows the Moduline terminal in cross section with the valve in three positions — shutoff, partially open and fully open. The valve opening varies with the pressure of the bellows and the pressure of the plenum.

Figure 33 shows the internal components of the Moduline unit.

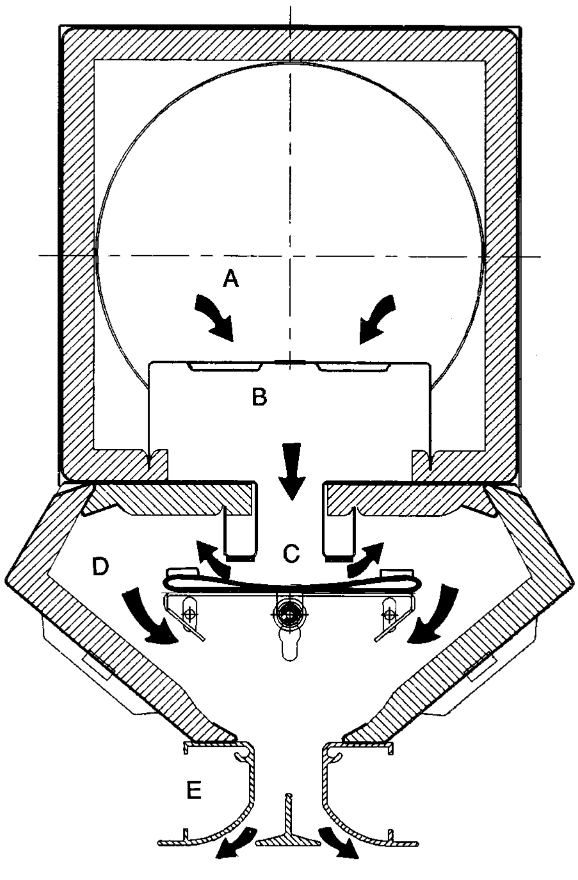
Figure 34 shows the comparison of operating characteristics between Carrier's new Moduline unit (the 37HS) and the previous design.



UNIT SHUTOFF — BELLOWS FULLY INFLATED



UNIT MODULATING — BELLOWS PARTIALLY INFLATED



UNIT FULL CAPACITY — BELLOWS DEFLATED

Fig. 32 — Bellows and Unit Air Valve Arrangement

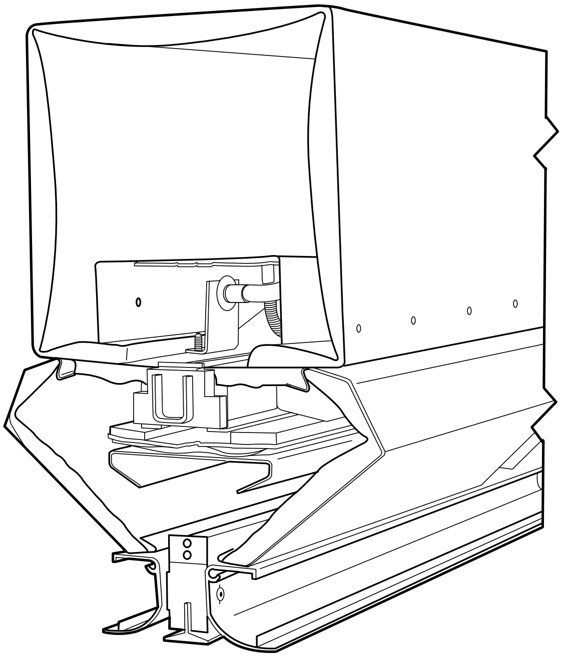


Fig. 33 — Cross Section of 37HS Moduline Air Terminal

HIGH AND LOW PRESSURE — As primary air flows from the unit plenum to the unit air valve and from there to the conditioned space, it passes through a slotted plate called the distribution baffle. The resistance of the baffle tends to "even out" the airflow through the unit. The baffle also creates a pressure differential which forms the basis of the sensing side of the unit control.

Static pressure from above the baffle is called the high pressure; static pressure below the baffle is the low pressure. Figure 35 shows the pick-up tubes for the high and low pressures, the differential pressure across the distribution baffle.

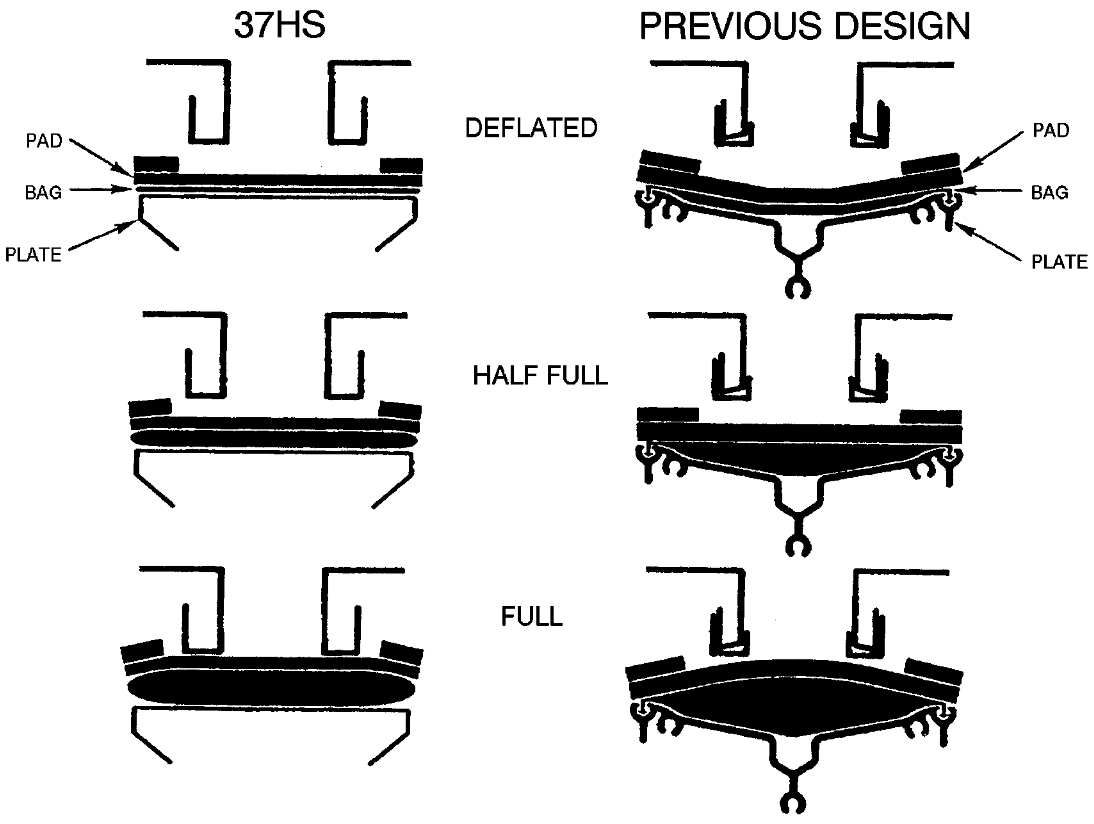


Fig. 34 — Bellows Comparison

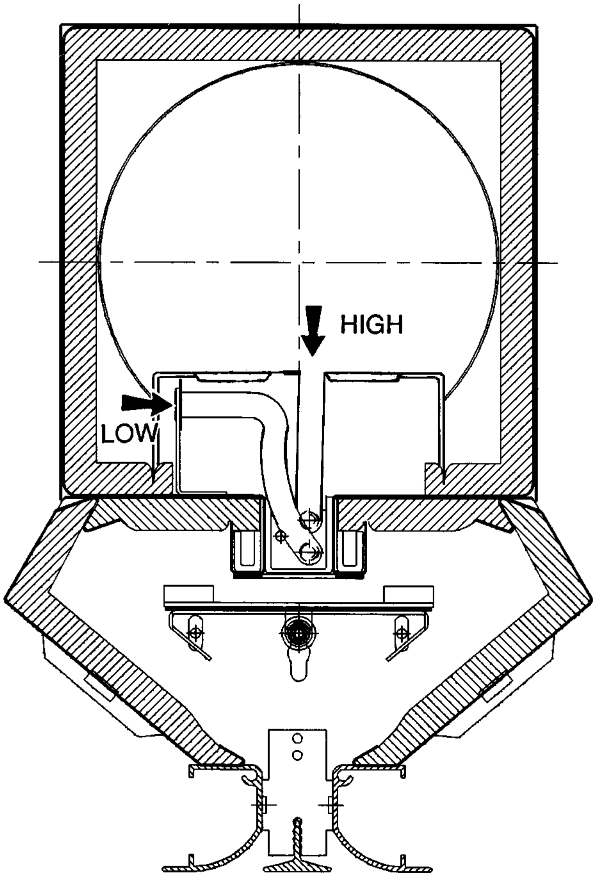


Fig. 35 — High and Low Pressure Pick-Up Tubes

BELLOWS PRESSURE — As the airflow through the unit changes, the high and low pressures vary proportionately. Comparing these 2 pressures, the unit volume controller provides a bellows pressure which in turn inflates the unit air valve. Bellows pressure varies from near zero at full flow to plenum or duct pressure at shutoff.

UNIT AIRFLOW DELIVERY — The relationship between the bellows pressure and the plenum pressure determines the unit air valve position, which controls unit airflow delivery. When the pressures become nearly equal, the valve closes and the unit shuts off. Conversely, as the bellows pressure approaches zero, the valve opens completely and the unit delivers maximum flow, as determined by the existing plenum pressure. Units normally operate between these extremes. In constant volume applications, the bellows pressure is automatically adjusted in proportion to the plenum pressure, providing a constant pre-set flow within the operating limits of the unit. In variable air volume operation, the bellows pressure is further modulated to reduce flow below the preset level as load requirements are satisfied. After passing through the valve, the primary air flows down through the diffuser and out to the conditioned space.

CONTROL APPLICATIONS

Introduction — The Moduline® terminal is offered with a variety of cooling and heating control options which adapt to many building applications. In this section, the various control applications are described and the functions they include are identified. Each application has a function number which corresponds to the function number shown in Tables 14 and 15 in the Control Selection section, page 50. Table 14 describes the functions; Table 15 shows the control packages required for each function. The part numbers shown are found on the Moduline air terminal price pages.

Detailed operating sequences for each control application are found beginning on page 55.

System-Powered Controls

COMPONENTS OF THE SYSTEM-POWERED CONTROL SYSTEM — The 37HS system-powered control consists of a set of custom design and manufacturer's components which provide airflow and temperature regulation of a Moduline air terminal. These devices are interchangeable, field-installed components which plug into the Moduline unit without the use of tools.

Figure 36 shows the basic components: Control block (part of the unit); filter/manifold; volume controller; and thermostat. Figure 37 demonstrates the control air paths in a sectional view of the control system. Note that the high pressure and low pressure pick-ups of the unit are connected through the control block to the filter and from there to the volume controller and thermostat.

Figure 38 shows the control filter/manifold; Fig. 39, the airflow volume controller; Fig. 40, the diffuser thermostat with aspirator; and Fig. 41, the wall thermostat and alternate to diffuser mounting.

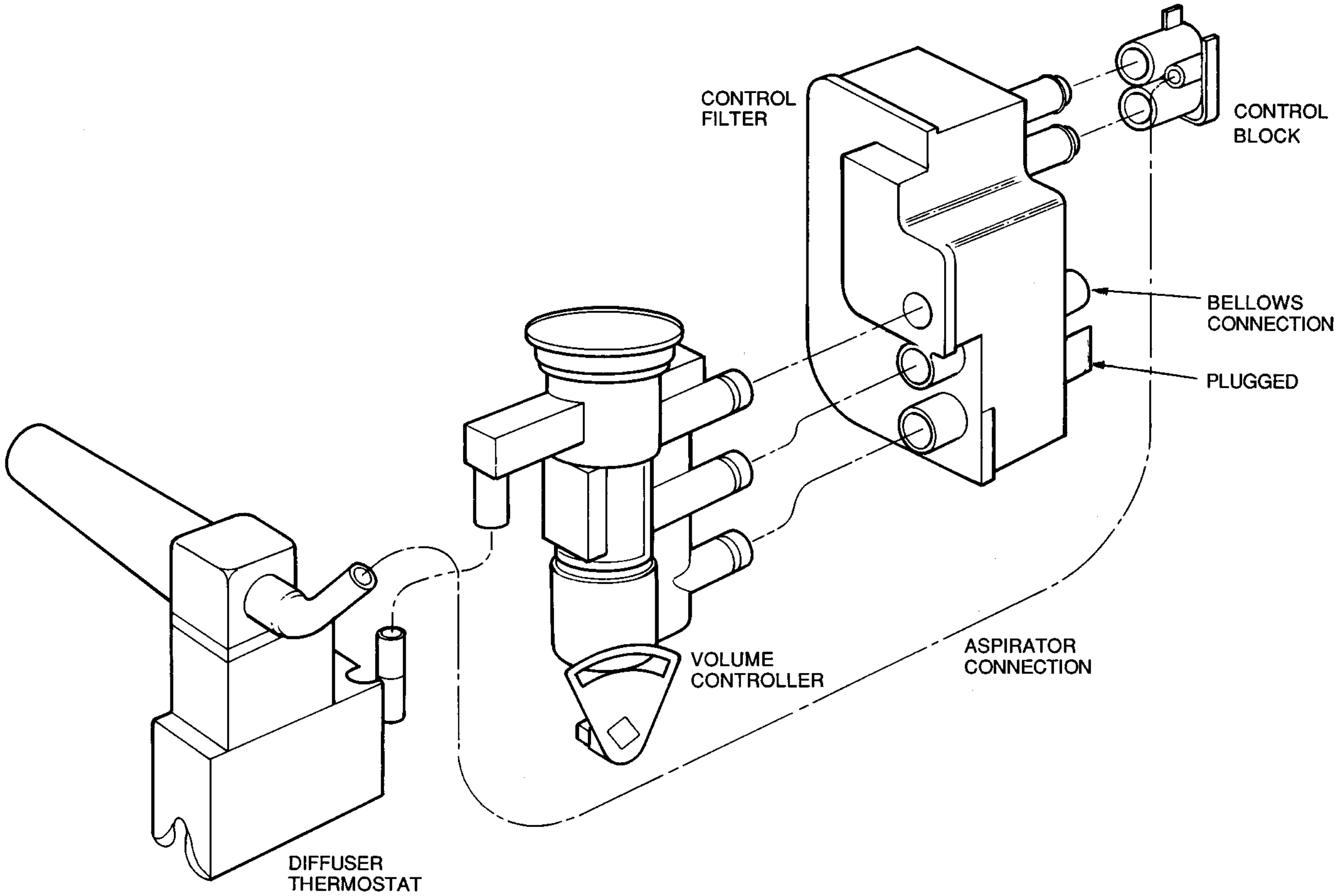


Fig. 36 — 37HS Control Components

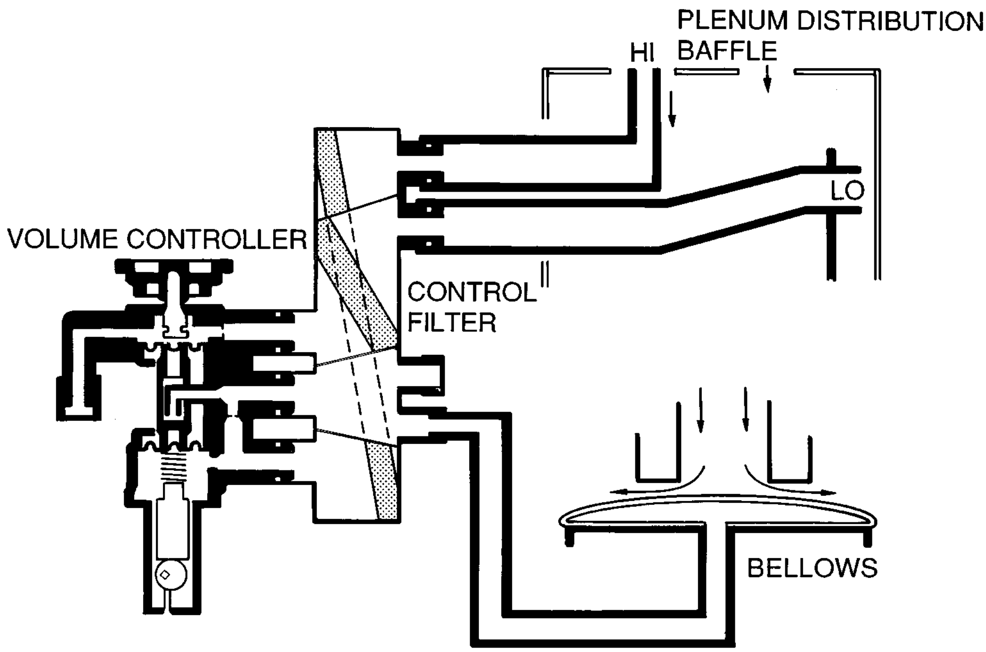


Fig. 37 — Basic 37HS Control Operation

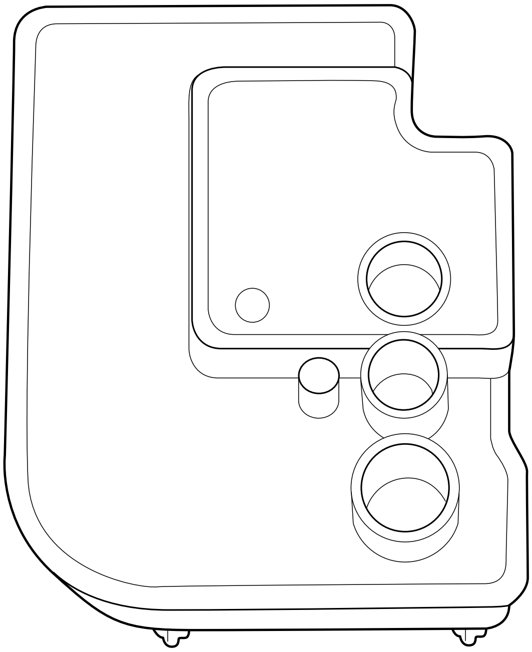


Fig. 38 — 37HS Control Filter/Manifold

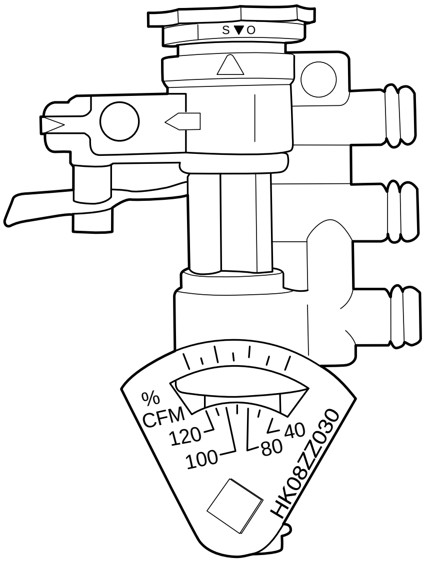


Fig. 39 — 37HS Airflow Volume Controller

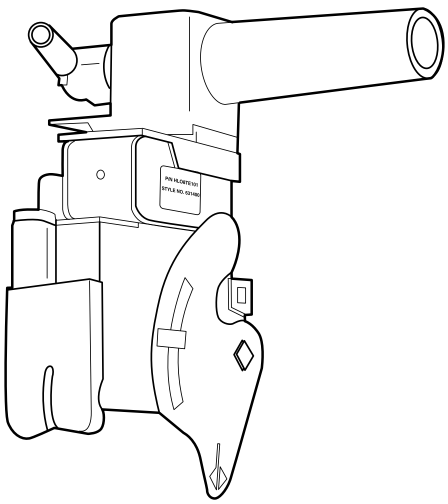


Fig. 40 — Unit-Mounted (Diffuser) Thermostat

Both CV and VAV control packages include a plastic baffle which is installed over the vertical leg of the center diffuser and blocks the unused portion of the diffuser slots. See Fig. 42. On VAV units, this prevents stray air currents from influencing thermostat operation.

Other control components used in extended system-powered electric and pneumatic control schemes are described in the control applications which follow.

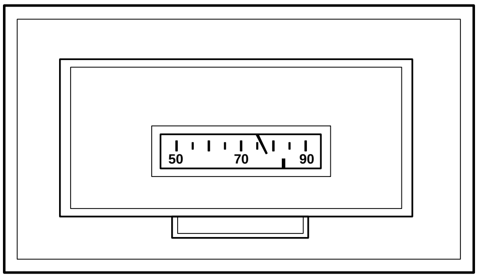


Fig. 41 — Wall-Mounted Thermostat

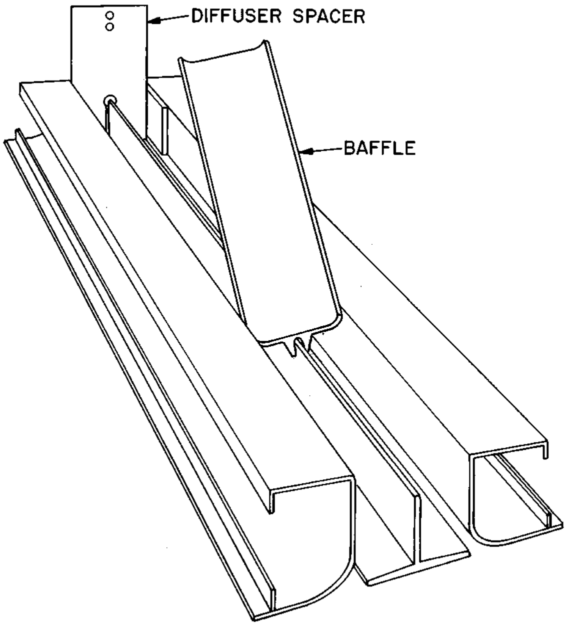


Fig. 42 — Diffuser Baffle Assembly

SYSTEM-POWERED APPLICATIONS

Constant Volume (CV) Cooling — (Function No. 1.) This is the most basic operating configuration. The control arrangement consists of the volume controller and the filter. The unit maintains a steady flow of primary air at the quantity set on the volume controller over a range of supply pressures. Figure 43 shows constant volume controls mounted on the Moduline® unit.

CV Heating (Function No. 1.) Constant volume heating controls are the same as for CV cooling.

Variable Air Volume (VAV) Cooling — (Function No. 2 and 3.) The addition of a cooling thermostat to the constant volume controls allows the unit to vary the flow of primary air. The unit will provide just enough airflow to satisfy the thermostat setting at existing load conditions, up to the maximum flow set on the volume controller. The cooling thermostat is direct acting (DA); thus the branch pressure output from the thermostat increases as the space temperature increases. Both diffuser-mounted and wall-mounted variations are available. Figure 44 shows the system-powered VAV controls (with diffuser thermostat) mounted on the unit.

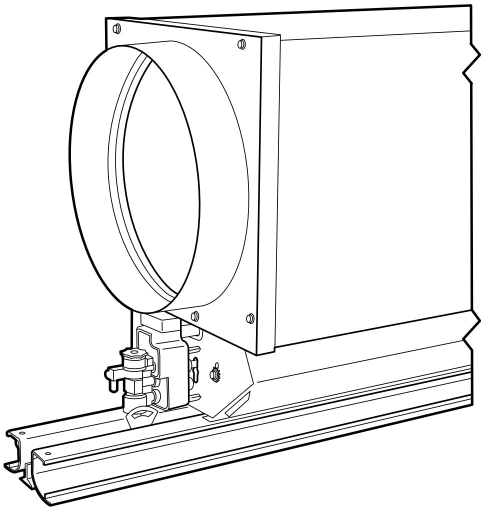


Fig. 43 — Constant Volume Control Arrangement

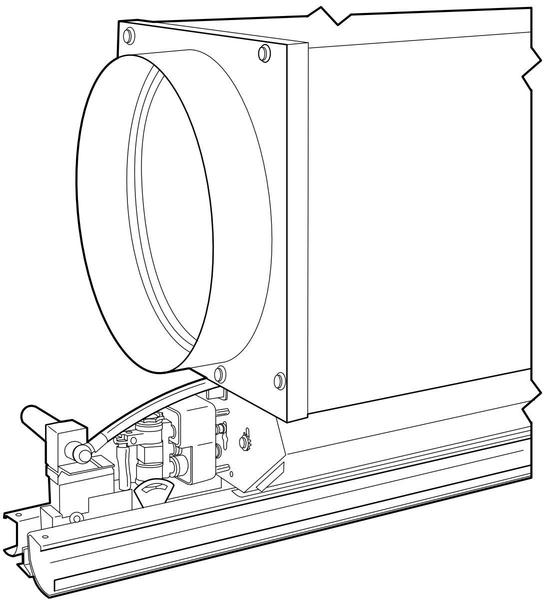


Fig. 44 — Variable Air Volume Control Arrangement

VAV Cooling With Warm-Up — (Function 4.) During an extended off period (overnight or during a holiday), the space temperature will often be lowered. It is necessary to provide heated air, temporarily, to reestablish comfortable temperatures when occupancy resumes. Since the cooling thermostats are satisfied at the reduced temperature, the units will be shut off and the system will not be able to deliver warm air. It is necessary, therefore, to provide a means of temporarily overriding the cooling thermostat. System-powered warm-up is achieved by adding a warm-up switch to the VAV cooling control arrangement (Fig. 45). The warm-up switch, located inside the unit plenum, closes when it senses that warm air is being supplied to the unit. This causes the bellows to bleed, opening the unit. This condition is maintained until cool air is returned to the system and the warm-up switch, sensing cool supply air, returns control to the thermostat.

Where all Moduline units on a main duct-run are provided with thermostats for variable air volume control, it is often difficult to get warm air to the end units on a run; with the units in shutoff there is no significant flow which will trigger the warm-up switch. Solutions to this situation are found on page 58 in the Control Operating Sequences, VAV Cooling with Warm-Up section.

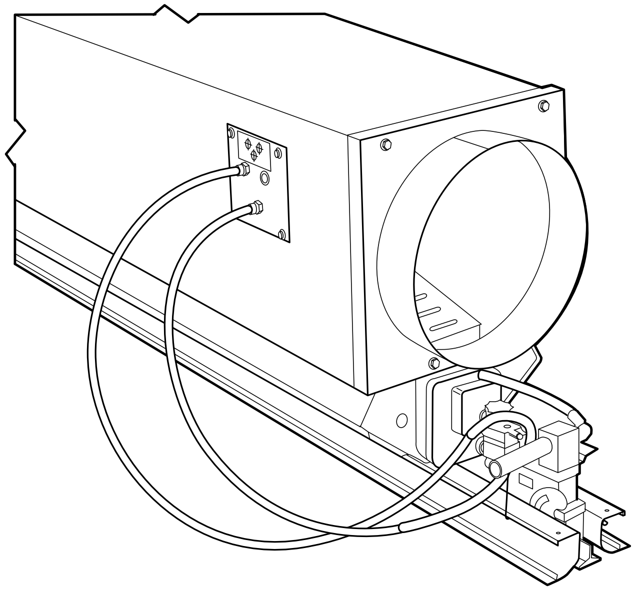


Fig. 45 — VAV Control Arrangement for System-Powered Warm-Up

VAV Heating and Cooling With Changeover — (Function 5.) A VAV control arrangement for cooling/heating includes a wall-mounted cooling/heating thermostat and provision to change the thermostat from cooling to heating configuration and back again. Figure 46 shows the control arrangement with Moduline® control for heating and cooling. The wall thermostat is shown in Fig. 47. The system-powered heating and cooling changeover uses an assembly consisting of 2 temperature-operated pneumatic switches located inside the unit plenum and installed in-line between a cooling/heating thermostat and the volume controller. These switches sequence the thermostat between the cooling and heating modes, depending upon the temperature of the primary air supply.

VAV Heating — (Function 9.) Variable air volume heating controls are the same as for VAV cooling except that only a wall-mounted heating thermostat is offered (Fig. 48). The heating thermostat is reverse acting (RA); thus the output pressure decreases as the space temperature increases.

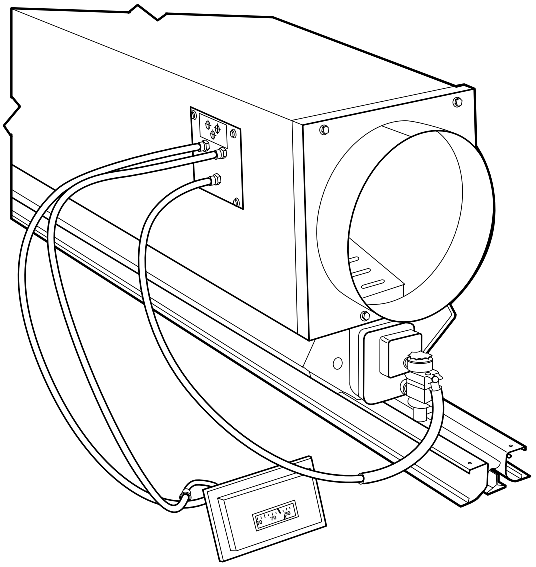


Fig. 46 — System-Powered Changeover Switch Arrangement with Heating/Cooling Wall Thermostat

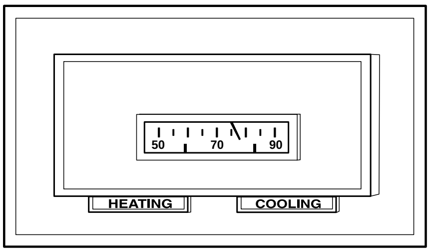


Fig. 47 — Cooling/Heating Wall Thermostat

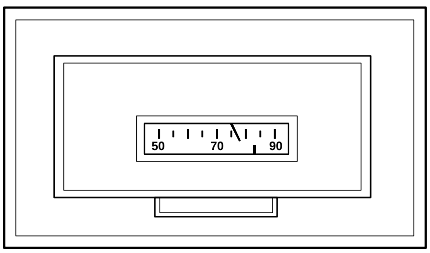


Fig. 48 — Wall-Mounted Heating Thermostat

SYSTEM-POWERED CONTROLS WITH ELECTRIC INTERFACE

VAV Cooling With Electric Warm-Up — (Function 6.) Electric warm-up uses an electric changeover valve to perform the same function as system-powered warm-up; that is, to provide heated air to reestablish comfortable temperatures when occupancy resumes after an extended unoccupied period. Since the cooling thermostats are satisfied at the reduced temperature, the units will be shut off and the system will not be able to deliver warm air. It is necessary, therefore, to provide a means of temporarily overriding the cooling thermostat.

The changeover control is an electrically operated, remotely controlled 3-way solenoid valve. The normally closed port of the valve is capped. The valve usually is wired to activate automatically with the supplemental heating switch; however, it can also be manually activated. This option may be used with either a unit-mounted or wall-mounted thermostat. See Fig. 49.

VAV Heating and Cooling With Electric Changeover — (Function 7.) A VAV control arrangement for cooling/heating includes a wall-mounted cooling/heating thermostat (Fig. 47) and provision to change the thermostat from a cooling to heating configuration and back again. System-powered cooling/heating with electric changeover uses a 3-way electric solenoid valve to switch control between the cooling and heating functions of a cooling/heating wall-mounted thermostat. It is installed in-line between the volume controller of a CV cooling control package and the thermostat. The valve may be activated separately or interlocked with an electric heating system. See Fig. 50.

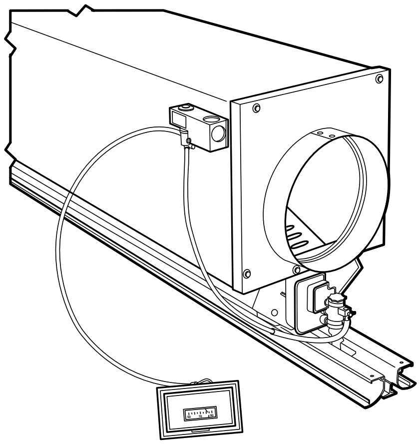


Fig. 49 — VAV Control Arrangement for Electric Warm-Up

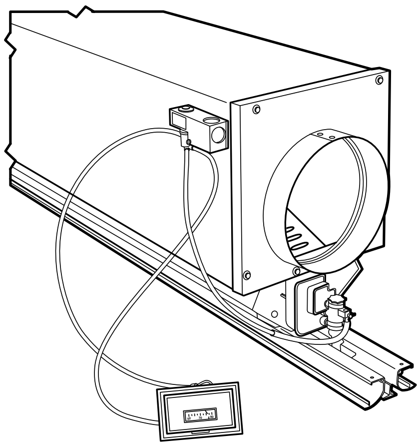


Fig. 50 — VAV Control Arrangement for Electric Changeover

VAV Cooling With Electric Heat Interlock — (Function 8.) In cases where VAV cooling terminals are used in conjunction with a separate heating system, such as perimeter heating, it is necessary to prevent the heating equipment from turning on before the cooling system turns off. The addition of a differential pressure switch to the unit controls makes this possible. When the switch detects that control pressures are approaching a shutoff condition (cooling load satisfied), it closes a set of contacts. This allows the heating system to operate as the heating thermostat dictates. See Fig. 51.

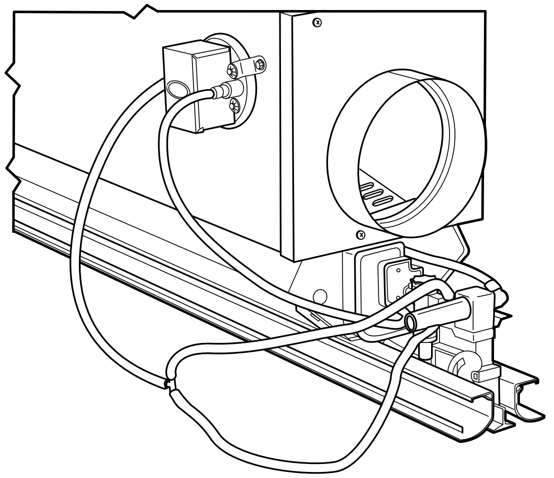


Fig. 51 — VAV Control Arrangement with Electric Heat Interlock

SYSTEM-POWERED CONTROLS WITH PNEUMATIC INTERFACE — The Moduline unit is designed as a stand-alone, reactive air terminal in which the only source of energy for control purposes is the distribution air itself. There are applications where separate system energy affords additional control functions not possible with system power. This section covers the use of 20 psi pneumatic energy and standard and custom pneumatic devices for the application of Moduline terminals in a conditioning system.

Pneumatic Sequenced Cooling/Heating (Hot Water) — (Function 10.) A 37HS VAV cooling system can be sequenced with a hot water heating system through the use of a pilot valve and a single proportional pneumatic thermostat (one-pipe or 2-pipe). See Fig. 52. By properly matching the operating pressure ranges of the pilot valve and the field-supplied hot water heat valve, the system can be configured to automatically change over from cooling to heating and back again based on the thermostat branch line pressure. The cooling and heating functions can be separated by a deadband or they can be overlapped, depending upon pressure ranges selected. The system may be designed to use either of the following combinations:

- pilot valve (NO), hot water valve (NO) and thermostat (DA, one- or 2-pipe)
- pilot valve (NC), hot water valve (NC), and thermostat (RA, one- or 2-pipe)

VAV Cooling With Pneumatic Warm-Up — (Functions 11 and 12.) Pneumatic warm-up is accomplished by using a remotely operated pneumatic switch in place of the system-powered warm-up switch. The pneumatic switch is installed in-line between the volume controller and the thermostat (unit mounted or wall mounted) and must be closed during warm-up. It may be either normally open or normally closed, but must match the pneumatic line pressure available. See Fig. 53.

VAV Cooling With Fire Safety — (Functions 11 and 12.) Code requirements may specify that air distribution terminals be open or closed during a fire. For example, in tower construction there may be a requirement that if a fire begins on one floor the terminals on the ‘‘fire floor’’ must be shut off to prevent the addition of oxygen to the fire; terminals on the floors above and below the fire floor must be wide open to ventilate the space. These actions must occur regardless of the space temperature and the position of the individual duct-powered thermostats (unit mounted or wall mounted). This application is effectively the same as the pneumatic warm-up previously described. In this case, the pneumatic switch is remotely operated by the fire master control to open the adjacent floor units. Air supply to units on the ‘‘fire floor’’ is interrupted by the use of duct fire-dampers.

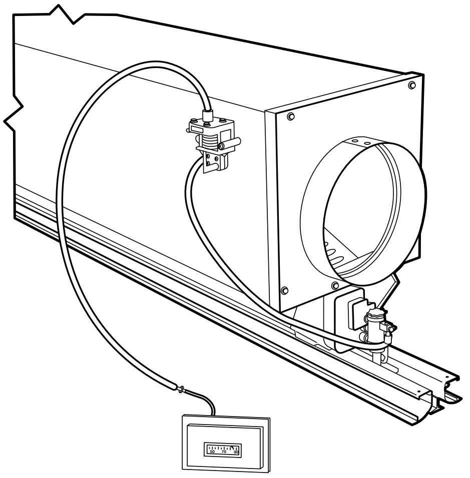


Fig. 52 — Pilot Valve for Pneumatic Sequenced Cooling/Heating (Hot Water)

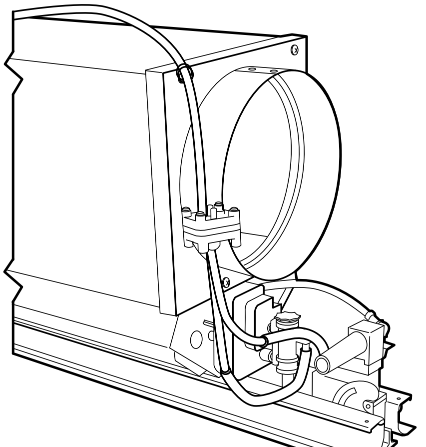


Fig. 53 — VAV Control Arrangement with Pneumatic Warm-Up Switch

NOTE: The following applications require the control packages shown for Function 10, plus field-supplied thermostats as described below.

Night Set Back Heating — In the interest of energy conservation, it may be desirable to raise a system's cooling set point during unoccupied time periods, whether they occur at night or on weekends, holidays or other occasions. This application requires a field-supplied dual set point DA pneumatic thermostat operating on a switched-main pressure supply. The air supply must have 2 pressure levels available. A normally open pilot valve, controlled by the dual thermostat, is also required. The thermostat set point is determined by the supply pressure selected.

VAV Cooling/Separate System Heating — A Moduline® cooling system may be interlocked with a separate hot water heating system and controlled by a common thermostat. This application requires a field-supplied switched-main pressure supply, a field-supplied dual set point DA/RA pneumatic thermostat, a pneumatic switching relay, a pilot valve, and a pneumatic hot water valve. The summer mode (cooling) or the winter mode (heating) is selected by switching the pneumatic supply system pressure between high or low pressure ranges. The pneumatic thermostat operates in either the cooling mode (DA) or the heating mode (RA) depending on the supply pressure provided. The pneumatic switching relay responds to the pressure level by selecting either the pilot valve and the Moduline cooling system or the hot water valve and the hot water heating system, to match the thermostat mode.

CONTROL SELECTION

Control Index — Table 14 summarizes the control functions available with 37HS Moduline air terminals. These functions are described in detail in the preceding Control Applications section.

Control Packages — In order to obtain a desired set of control functions with Moduline air terminals, the correct combination of control packages is required. Table 15 shows the control packages that must be installed on a master unit in order to achieve each function. The control package numbers correspond to the numbers on the 37HS Price Pages.

Table 14 — Control Index

FUNCTION NO.	FUNCTION DESCRIPTION
1	Cooling or Heating Only, Constant Volume
2	Cooling Only, Variable Volume, Diffuser Thermostat
3	Cooling Only, Variable Volume, Wall Thermostat
4	VAV Cooling with System-Powered Warm-Up, Wall Thermostat
5	VAV Cooling/Heating, System-Powered Changeover, Wall Thermostat
6	VAV Cooling with Electric Warm-Up, Wall Thermostat or Diffuser Thermostat
7	VAV Cooling/Heating, Electric Changeover, Wall Thermostat or Diffuser Thermostat
8	VAV Cooling with Electric Heat Interlock
9	Heating Only, Variable Volume, Wall Thermostat
10	VAV Cooling with Pneumatic Sequenced Heating (Hot Water) and Pneumatic Thermostat*
11	VAV Cooling with Pneumatic Warm-Up or Fire Safety Switch, Wall Thermostat
12	VAV Cooling with Pneumatic Warm-Up or Fire Safety Switch, Diffuser Thermostat

*For night set back heating, a field-supplied dual set point DA thermostat must be used with the control packages and components shown in Table 15. For VAV cooling/separate system heating, a field-supplied dual set point DA/RA thermostat must be used with the control packages and components shown in Table 15.

Table 15 — 37HS Control Combinations

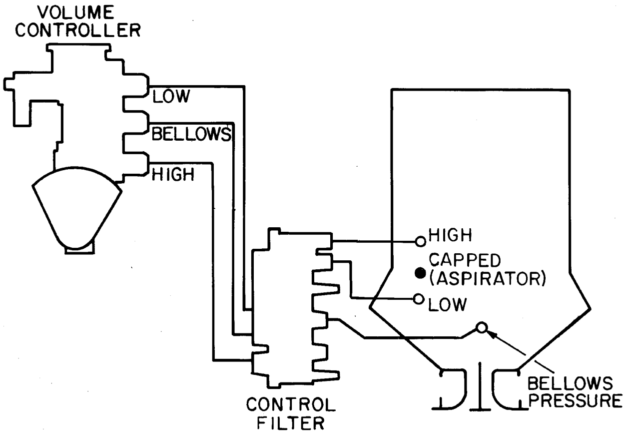
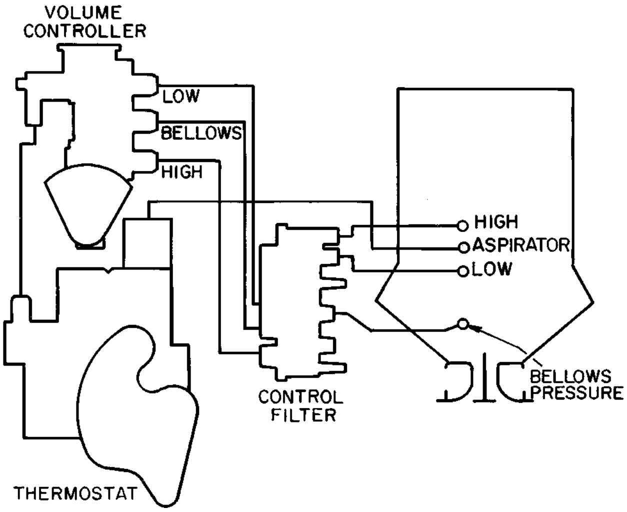
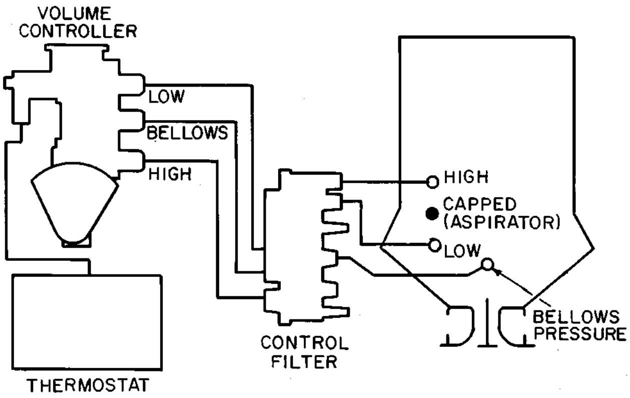
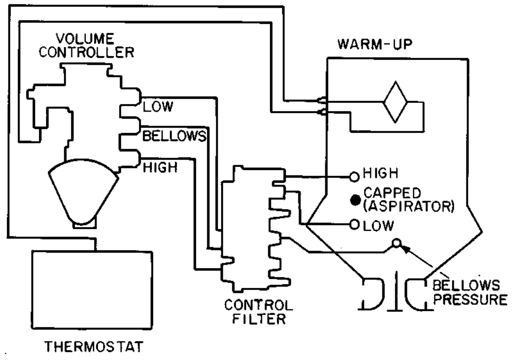
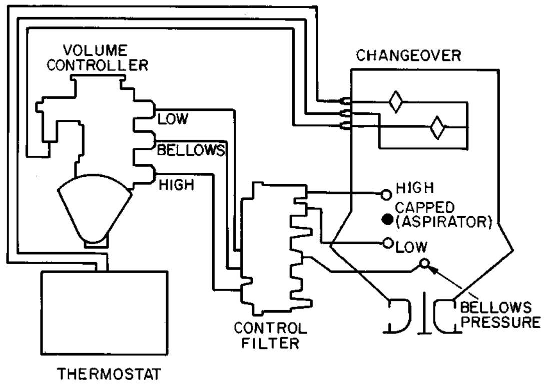
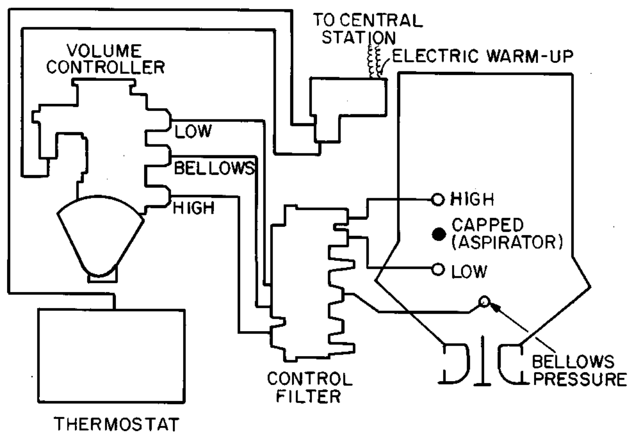
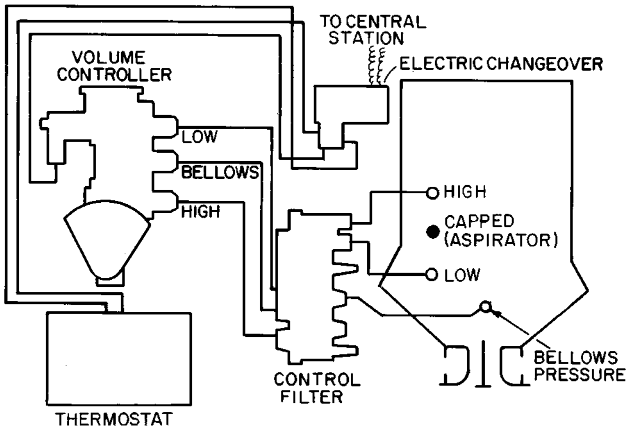
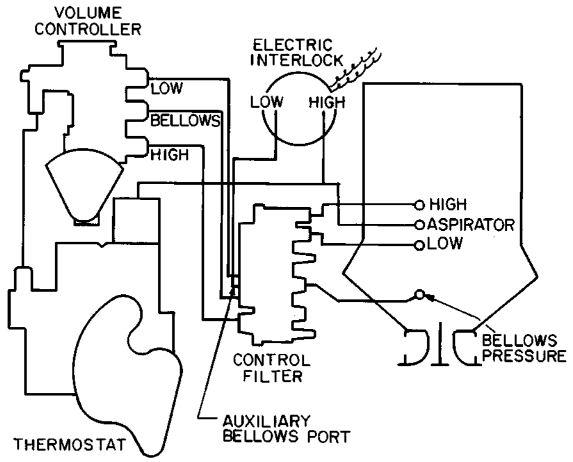
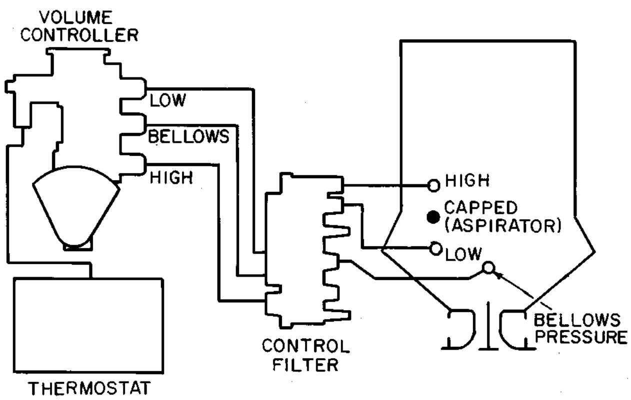
NO.	FUNCTION	MODEL	CONTROL PACKAGES REQUIRED	CONNECTION ARRANGEMENT
1	**SYSTEM POWERED** **CONSTANT VOLUME COOLING**	37HS1 37HS2 37HS4	37HS900003 37HS900003 37HS900003	
2	**SYSTEM POWERED** **VARIABLE VOLUME COOLING** **DIFFUSER THERMOSTAT**	37HS1 37HS2 37HS4	37HS900001 37HS900002 37HS900004	
3	**SYSTEM POWERED** **VARIABLE VOLUME COOLING** **WALL THERMOSTAT**	37HS1 37HS2 37HS4	37HS900003 37CM901012 37HS900003 37CM901012 37HS900003 37CM901012	

Table 15 — 37HS Control Combinations (cont)

NO.	FUNCTION	MODEL	CONTROL PACKAGES REQUIRED	CONNECTION ARRANGEMENT
4	SYSTEM POWERED VARIABLE VOLUME COOLING SYSTEM POWERED WARM-UP WALL THERMOSTAT*	37HS1	37HS900003 37CM900152 37CM901012	
		37HS2	37HS900003 37CM900152 37CM901012	
		37HS4	37HS900003 37CM900152 37CM901012	
5	SYSTEM POWERED VARIABLE VOLUME HEATING & COOLING SYSTEM POWERED CHANGEOVER WALL THERMOSTAT	37HS1	37HS900003 37CM900192 37CM900992	
		37HS2	37HS900003 37CM900192 37CM900992	
		37HS4	37HS900003 37CM900192 37CM900992	
6	SYSTEM POWERED VARIABLE VOLUME COOLING ELECTRIC WARM-UP WALL THERMOSTAT*	37HS1	37HS900003 37CM900792† 37CM901012	
		37HS2	37HS900003 37CM900792† 37CM901012	
		37HS4	37HS900003 37CM900792† 37CM901012	

*To use a diffuser thermostat in place of the wall thermostat, replace constant volume package 37HS900003 and wall thermostat 37CM901012 with variable volume package 37HS900001 (37HS1), 37HS900002 (37HS2) or 37HS900004 (37HS4).
†Package 37CM900792 is 24 v; other voltages available.

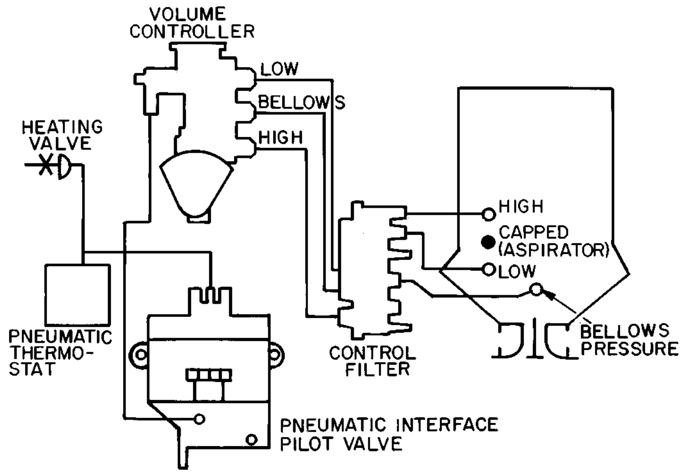
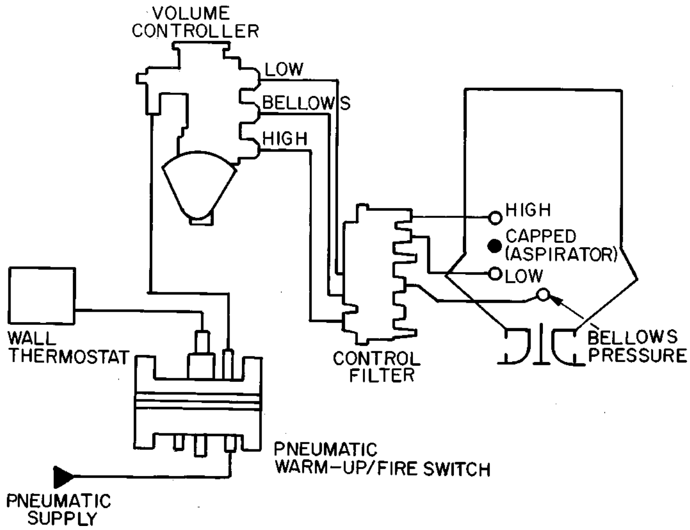
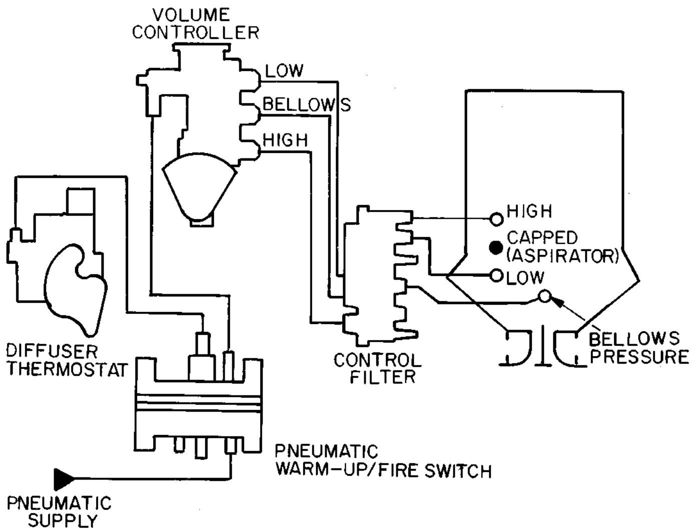
Table 15 — 37HS Control Combinations (cont)

NO.	FUNCTION	MODEL	CONTROL PACKAGES REQUIRED	CONNECTION ARRANGEMENT
7	**SYSTEM POWERED** **VARIABLE VOLUME HEATING & COOLING** **ELECTRIC CHANGEOVER** **WALL THERMOSTAT**	37HS1	37HS900003 37CM900792† 37CM900992	
		37HS2	37HS900003 37CM900792† 37CM900992	
		37HS4	37HS900003 37CM900792† 37CM900992	
8	**SYSTEM POWERED** **VARIABLE VOLUME COOLING** **DIFFUSER THERMOSTAT**** **ELECTRIC INTERLOCK TO FAN COIL OR BASEBOARD HEATING**	37HS1	37HS900001 37CM900922	
		37HS2	37HS900002 37CM900922	
		37HS4	37HS900004 37CM900922	
9	**SYSTEM POWERED** **VARIABLE VOLUME HEATING** **WALL THERMOSTAT**	37HS1	37HS900003 37CM901002	
		37HS2	37HS900003 37CM901002	
		37HS4	37HS900003 37CM901002	

†Package 37CM900792 is 24 v; other voltages available.

**To use a wall thermostat in place of the diffuser thermostat, replace variable volume packages 37HS900001 (37HS1), 37HS900002 (37HS2) or 37HS900004 (37HS4) with constant volume package 37HS900003 and add wall thermostat 37CM901012.

Table 15 — 37HS Control Combinations (cont)

NO.	FUNCTION	MODEL	CONTROL PACKAGES REQUIRED	CONNECTION ARRANGEMENT
10	**SYSTEM POWERED** **VARIABLE VOLUME COOLING** **PNEUMATIC PILOT VALVE FOR HEATING/COOLING SEQUENCE** **PNEUMATIC WALL THERMOSTAT††**	37HS1	37HS900003 37CM900972 (NO) with 37HS900007 (DA) 37CM900982 (NC) with 37HS900008 (RA)	
		37HS2	37HS900003 37CM900972 (NO) with 37HS900007 (DA) 37CM900982 (NC) with 37HS900008 (RA)	
		37HS4	37HS900003 37CM900972 (NO) with 37HS900007 (DA) 37CM900982 (NC) with 37HS900008 (RA)	
11	**SYSTEM POWERED** **VARIABLE VOLUME COOLING** **WALL THERMOSTAT** **PNEUMATIC WARM-UP/FIRE SWITCH**	37HS1	37HS900003 37CM901012 37HS900017	
		37HS2	37HS900003 37CM901012 37HS900017	
		37HS4	37HS900003 37CM901012 37HS900017	
12	**SYSTEM POWERED** **VARIABLE VOLUME COOLING** **DIFFUSER THERMOSTAT** **PNEUMATIC WARM-UP/FIRE SWITCH**	37HS1	37HS900001 37HS900017	
		37HS2	37HS900002 37HS900017	
		37HS4	37HS900004 37HS900017	

LEGEND

DA — Direct Acting
NC — Normally Closed
NO — Normally Open
RA — Reverse Acting

††For night set back heating, a field-supplied dual set point DA thermostat must be substituted for thermostat packages shown. For VAV Moduline® cooling/separate system heating, a field-supplied dual set point DA/RA thermostat must be substituted for thermostat packages shown.

CONTROL OPERATING SEQUENCES

System-Powered Controls

CV COOLING — See Fig. 54. Air from above the distribution baffle (high pressure) enters the filter through the upper port of the control block, while the lower port receives air from below the baffle (low pressure). These air streams pass through separate filter chambers where particulate contaminants are removed.

The low pressure air stream enters the low pressure chamber of the volume controller from the top port of the filter, while the bottom port of the filter feeds the high pressure stream into the controller's high pressure chamber.

Air from the high pressure chamber feeds into the bellows pressure chamber of the controller through the fixed orifice. Pressure in the bellows chamber of the volume controller is determined by the relationship between the entering flow resistance of the fixed orifice and the leaving flow resistance of the control valve variable orifice.

As the control valve opens, its resistance decreases and relatively more air is allowed to bleed, lowering the pressure in the bellows chamber. As the control valve closes, the effect is reversed, increasing the bellows pressure. This is the principle of control by matched orifices.

The control valve is positioned by 2 diaphragms, one in the low pressure chamber and one in the high pressure chamber, and an adjustable spring. Pressure above the low pressure diaphragm tends to open the control valve while the high pressure diaphragm tends to hold it closed. The spring tension balances these forces as the pressures vary and determines the valve position. Rotating the adjusting dial on the volume controller changes the spring tension and provides a means of establishing a flow set point.

The bellows pressure determined by the action of the control valve is communicated to the bellows. As the plenum pressure changes, the control bellows valve is constantly re-set to maintain a corresponding bellows pressure. The bellows pressure chamber of the volume controller feeds air back through the middle port and chamber of the filter (also called a bellows pressure chamber), to the bellows connection on the unit end panel, and into the bellows. The bellows pressure re-sets the bellows on the unit air valve to provide a constant airflow through the unit at the value selected on the volume controller dial.

CV HEATING — Control arrangements and operation are the same for CV heating as for CV cooling. The controls and their operation are not affected by the temperature of the supply air.

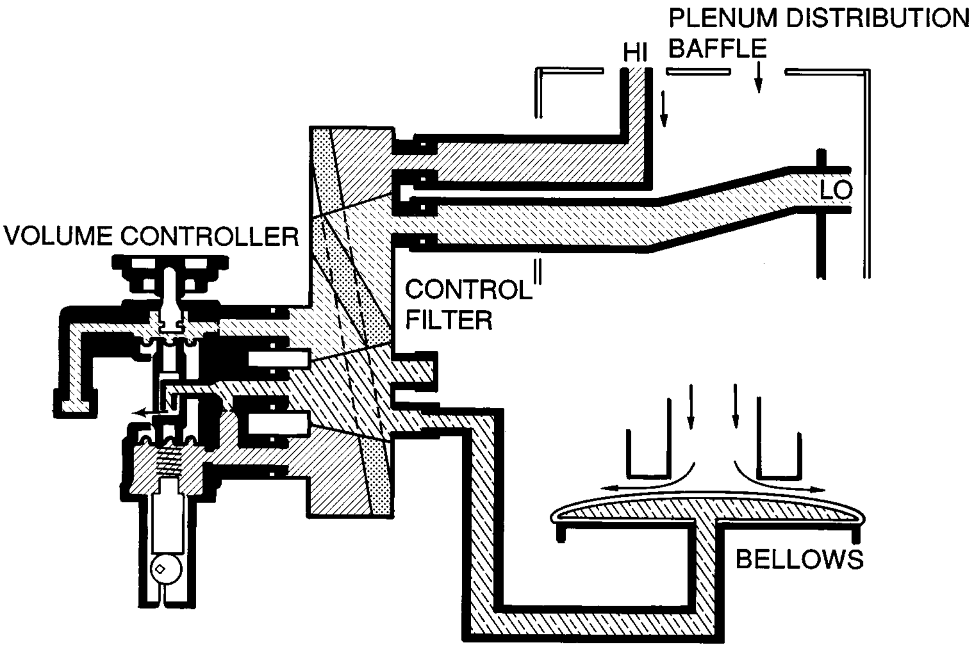


Fig. 54 — Constant Volume Controls — Controller Bleeding, Unit Supplying Air

VAV COOLING — In VAV operation, the filter and volume controller perform the same functions as in CV operation. The unit-mounted thermostat modifies control operation as described below.

Refer to Fig. 55. The air enters the low pressure chamber of the volume controller through a fixed orifice. The low pressure chamber is connected through a stub fitting and tube to the unit-mounted thermostat. The thermostat senses room temperature, closes its port as the temperature rises, and opens it as the temperature falls. This makes it possible to control the pressure in the low pressure chamber in response to the space temperature. With normal space temperatures, and the thermostat satisfied, the low pressure chamber valve is open to the atmosphere through the thermostat. The rate at which the valve bleeds air from the low pressure chamber is high in relation to the rate at which air enters through the orifice, and the pressure decreases in relation to the high pressure. The high pressure force is stronger than the low pressure force and the bleed valve of the bellows pressure chamber of the controller is held closed. Since no air escapes, the bellows pressure becomes equal to the high pressure in the plenum and the unit damper is closed, shutting off the unit.

As the room load increases, the space temperature increases. The thermostat senses this change and starts to close, raising the pressure in the low pressure chamber of the controller. As the low pressure rises, it gradually overcomes the high pressure and opens the bellows pressure-chamber bleed valve, lowering the bellows pressure proportionally. This allows the unit damper to open and gradually increase the flow of conditioned primary air into the space. See Fig. 56.

This process continues until the flow of primary air is sufficient to offset the load, or until the flow level set point of the volume controller is reached (Fig. 57). At this point, the thermostat bleed is closed and the unit is actually operating in CV configuration. As the load is reduced, the process is reversed and the unit flow decreases proportionally until the unit is shut off when the thermostat is satisfied (bleed fully open) (Fig. 58). In this manner, the unit normally delivers only the actual amount of primary air needed to offset the existing load.

When the wall-mounted DA thermostat is used in place of the unit-mounted thermostat, variable air volume control operation is the same as described above for the unit-mounted thermostat. The only difference is that the wall-mounted thermostat does not include the aspiration feature.

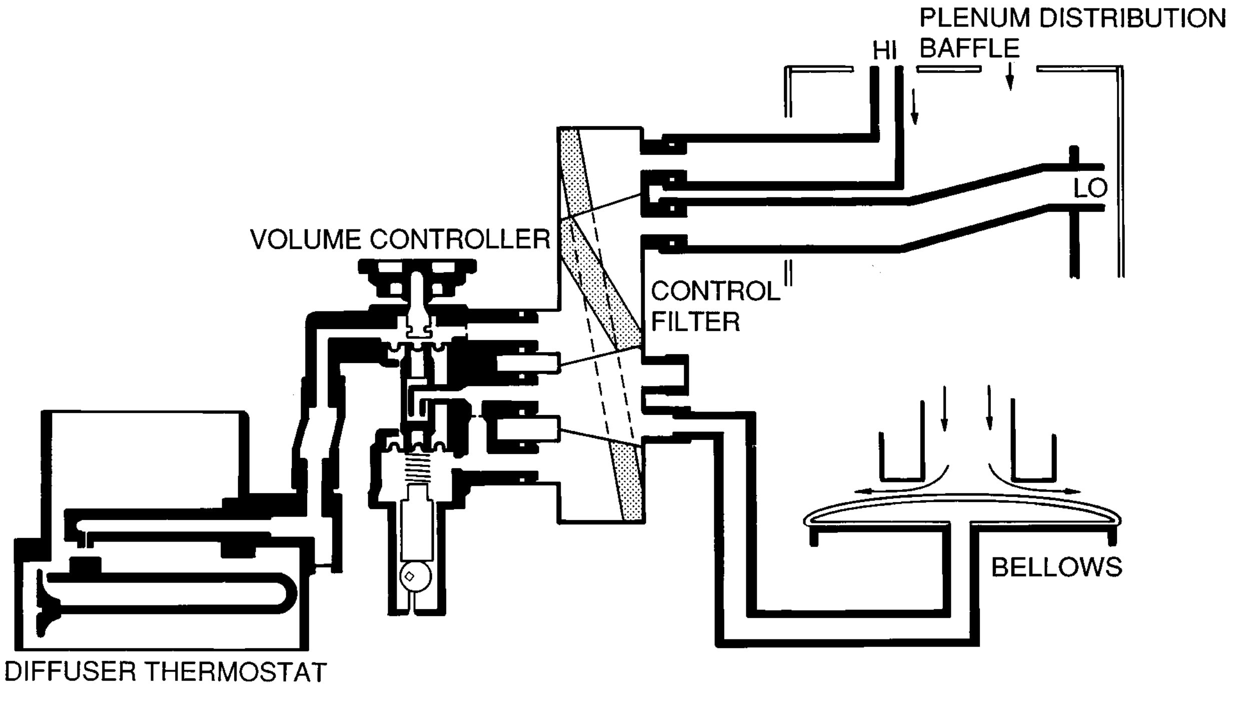


Fig. 55 — Variable Volume Controls Schematic

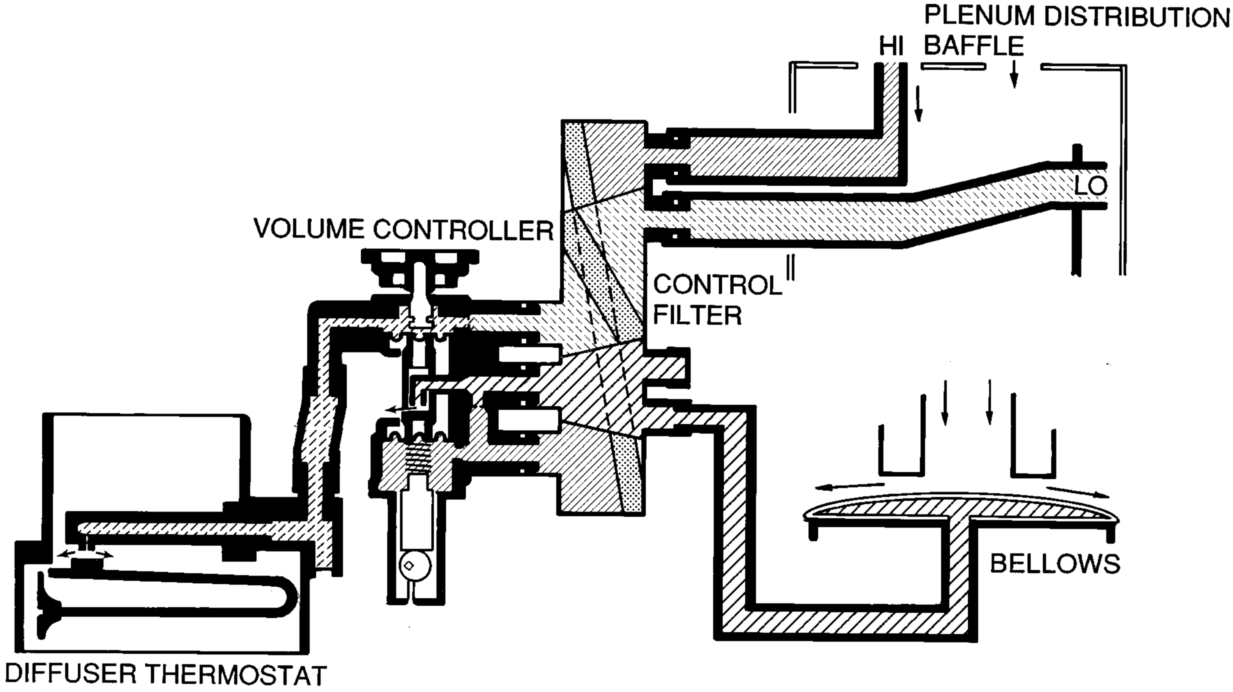


Fig. 56 — Variable Volume Controls — Minimum Flow: Thermostat Partially Open, Controller Partially Open, Unit Delivering Minimum Flow

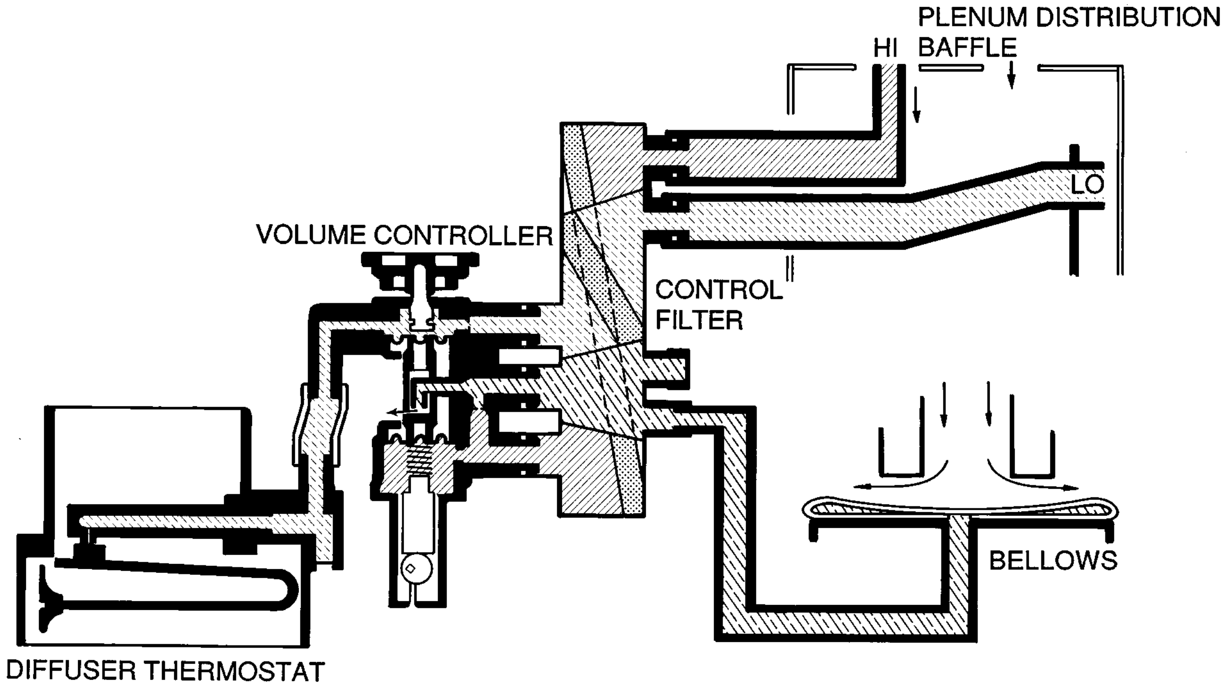


Fig. 57 — Variable Volume Controls — Full Cooling, Thermostat Closed, Controller Bleeding, Unit Supplying Air

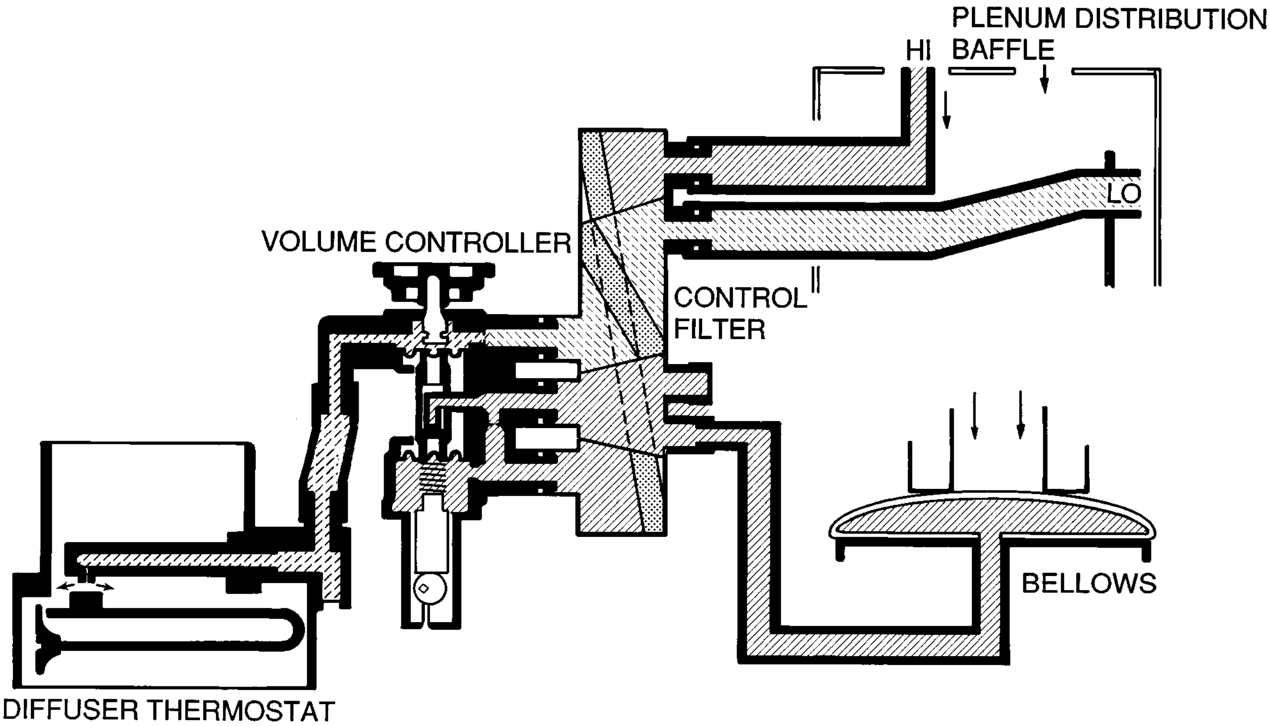


Fig. 58 — Variable Volume Controls — Thermostat Open, Controller Shut Off, Unit Shut Off

VAV COOLING WITH WARM-UP — Including the warm-up switch in the volume controller/thermostat circuit allows the unit to deliver air when there is warm air in the duct system, even though the cooling thermostat is satisfied by cool space temperature.

The warm-up switch is actually a temperature controlled pneumatic valve which is normally open at primary air supply temperatures below approximately 64 F. It is installed in-line between the volume controller and the thermostat.

When warm primary air is supplied to restore comfort conditions in the space after an extended shutdown, the warm-up switch reacts by closing (Fig. 59). This removes the thermostat from the control circuit and prevents air from bleeding from the low pressure chamber of the volume controller. This condition simulates a thermostat calling for maximum primary-air delivery. The unit is now, in effect, a CV unit and operates at the set point of the volume controller. This condition will continue as long as air in the duct system remains at a temperature higher than approximately 80 F. As the supply air returns to normal cooling temperatures, the switch opens and control is returned to the cooling thermostat. See Fig. 60.

Because the units are shut off, it may be difficult to establish the flow of warm air to initiate warm-up. One method of overcoming this problem is to install one or more CV units near the end of the duct run. Where possible, a constant volume unit is located in space not continuously occupied such as halls, aisles, or storage rooms. It can also be helpful in an area benefiting from continuous circulation. By locating such a unit at the end of a duct run, the heated air for morning warm-up is assured of reaching the VAV units. See Fig. 61.

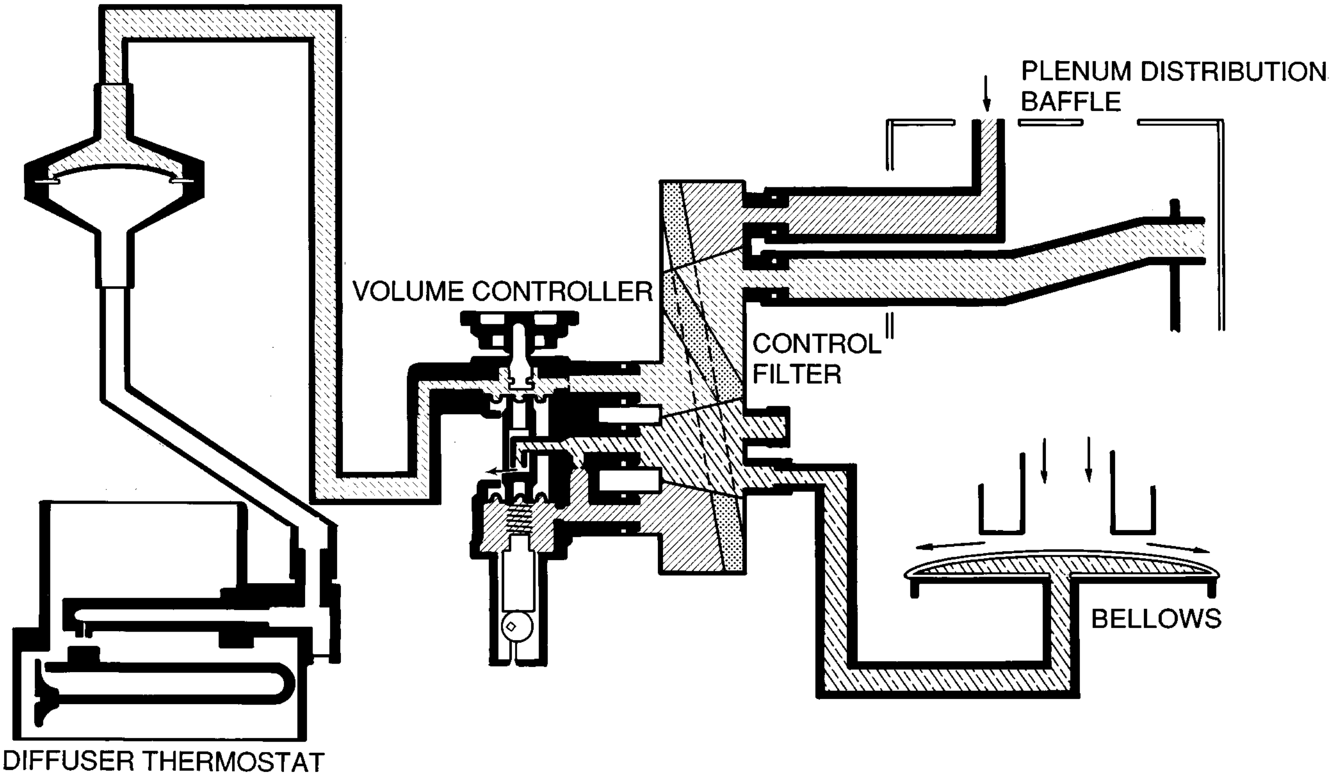


Fig. 59 — Cooling with Warm-Up — Morning, Hot Air in Duct, Warm-Up Switch Closed, Controller Bleeding, Unit Heating

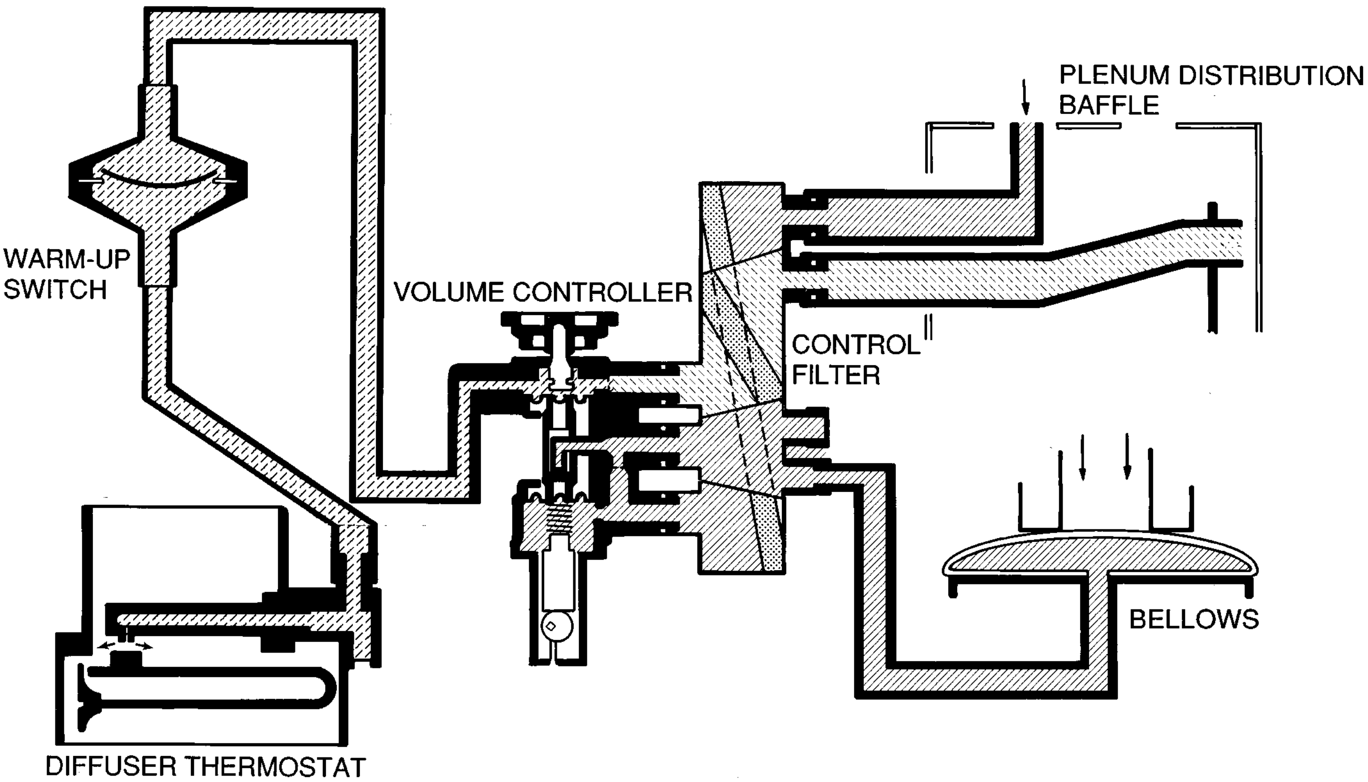


Fig. 60 — Cooling with Warm-Up — Nighttime Condition, Room Cool, Thermostat Open, Bleeding, Warm-Up Open, Controller Shut Off, Unit Shut Off

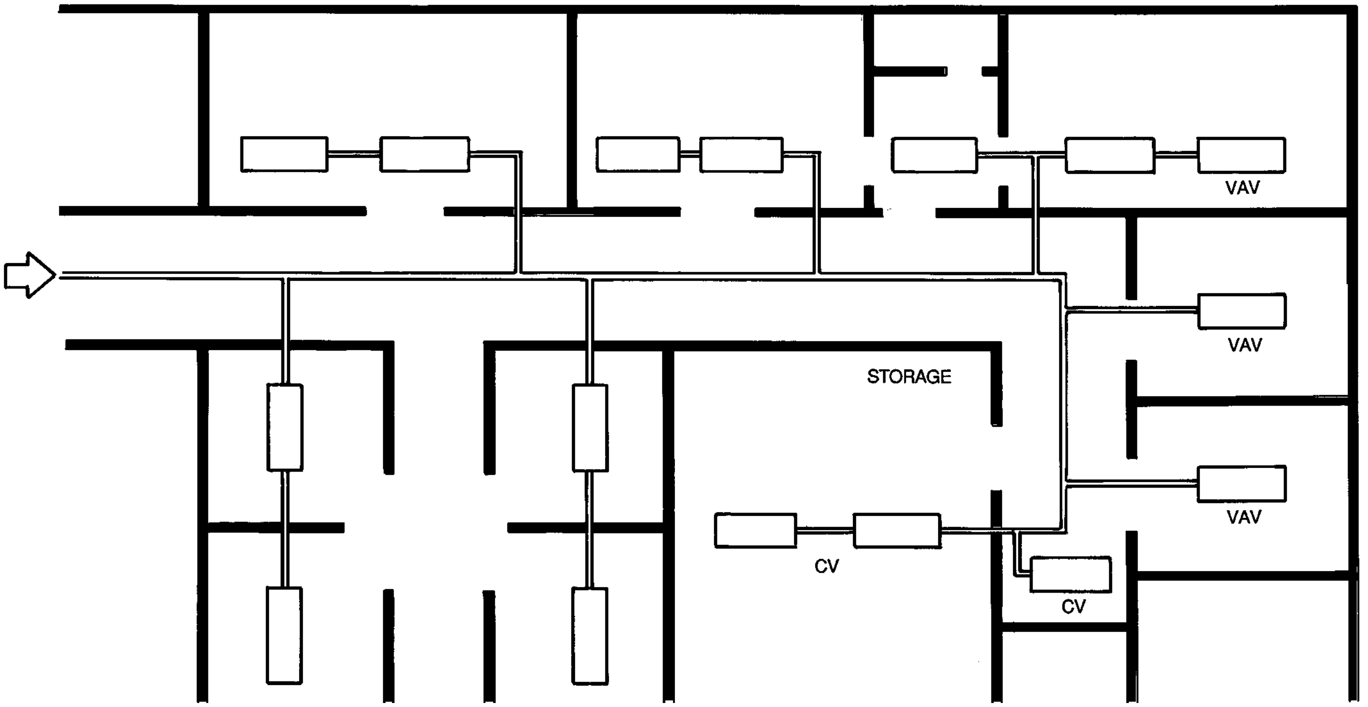


Fig. 61 — Location of CV Unit for Warm-Up Application

VAV HEATING AND COOLING WITH SYSTEM-POWERED CHANGEOVER — This application uses a CV control package along with a wall-mounted thermostat package (cooling/heating) and a system-powered changeover control package. The cooling thermostat is direct acting (DA) while the heating thermostat is reverse acting (RA).

Operation is very similar to system-powered warm-up. The changeover switch assembly is field installed in the unit plenum and is piped in-line between the volume controller and the thermostat. It consists of 2 thermally operated pneumatic valves, one for each thermostat. The tube from the volume controller is connected by a ‘T’ into the valve assembly, making control air available to each valve. The valve for the DA cooling thermostat is normally open as long as there is cool supply air in the plenum (Fig. 62). The other valve is normally open when warm air is being supplied, matching the RA heating thermostat (Fig. 63). Each valve is connected to the corresponding thermostat by a separate tube. In the cooling mode (Fig. 64), the cooling valve is open, activating the cooling thermostat, while the heating thermostat is isolated by the closed heating valve. On changeover from cooling to heating, the cooling valve closes and the heating valve opens, shifting control to the heating thermostat (Fig. 65).

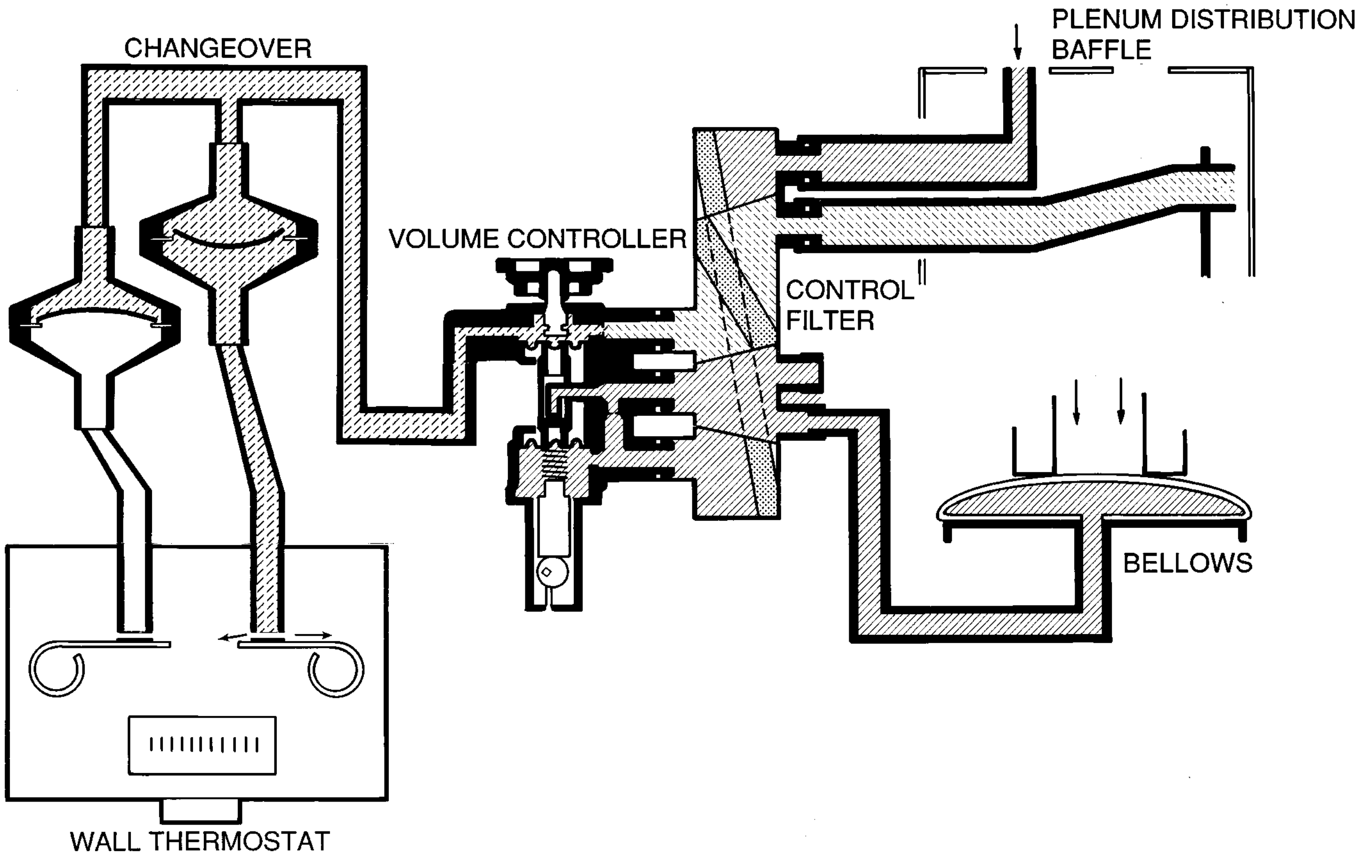


Fig. 62 — Heating/Cooling Unit — Cooling, Cold Air in Duct, Changeover in Cooling, Thermostat Open, Controller Shut Off, Unit Shut Off

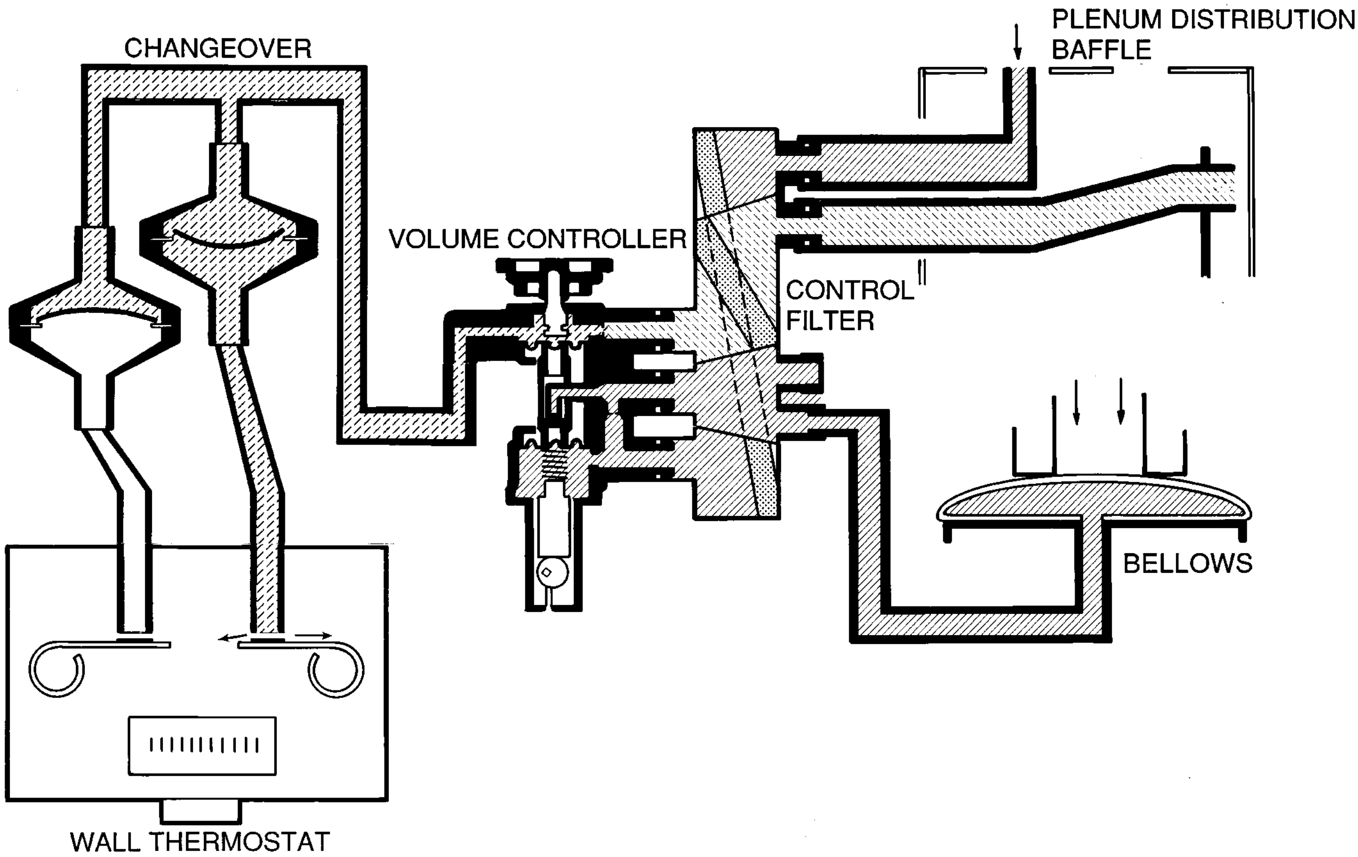


Fig. 63 — Heating/Cooling Unit — Heating, Hot Air in Duct, Changeover in Heating, Thermostat Open, Controller Shut Off, Unit Shut Off

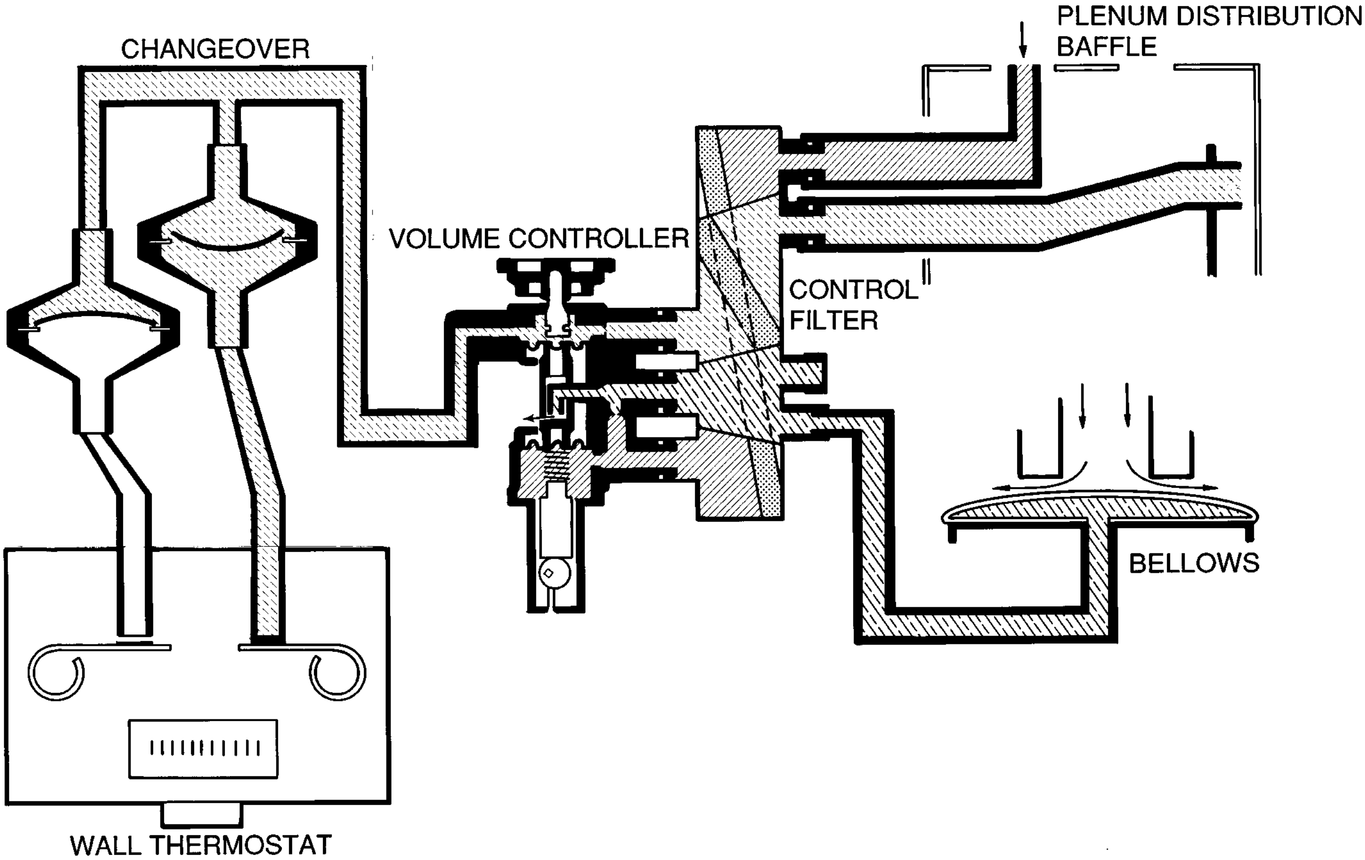


Fig. 64 — Heating/Cooling Unit — Cooling, Cold Air in Duct, Changeover in Cooling, Thermostat Closed, Controller Bleeding, Unit Cooling

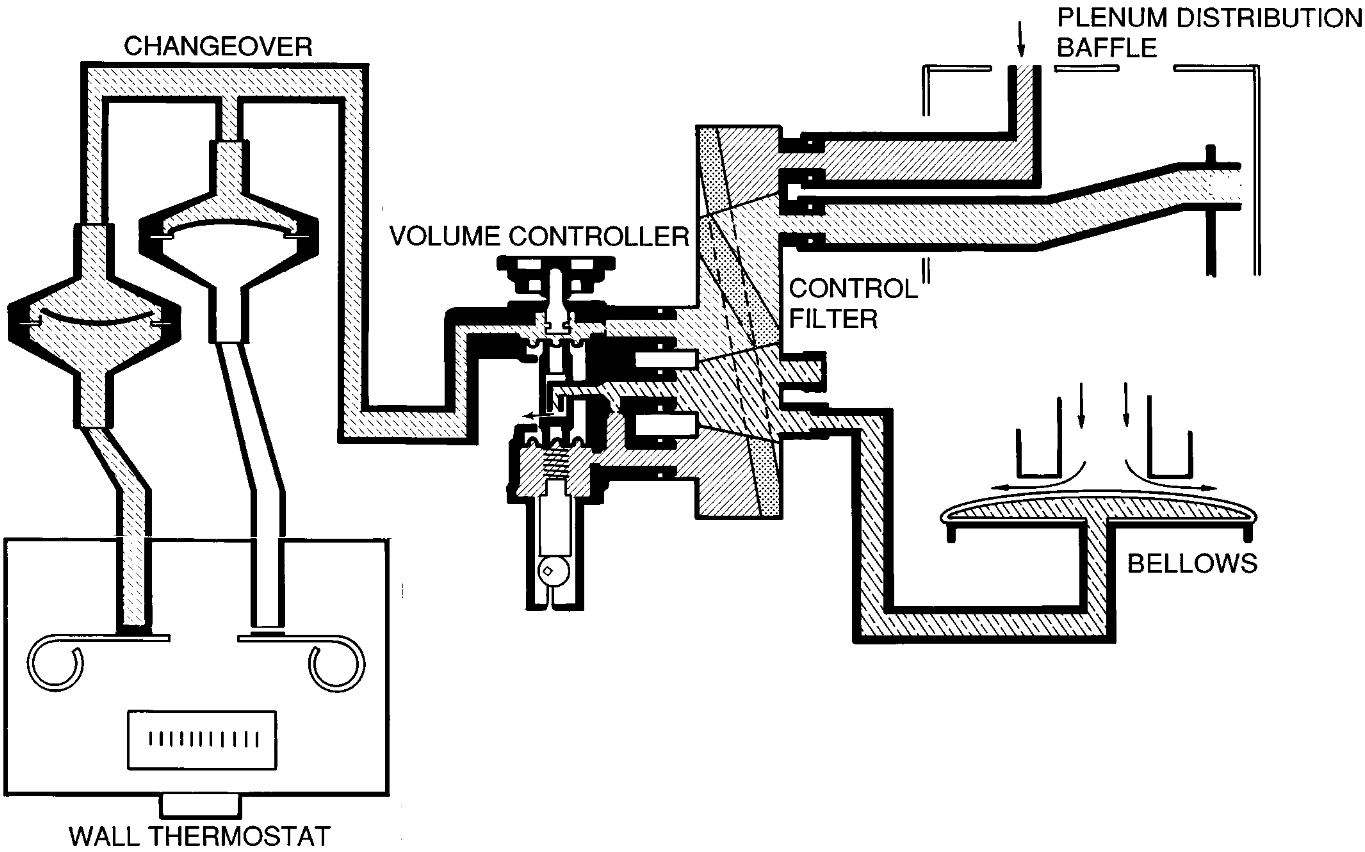


Fig. 65 — Heating/Cooling Unit — Heating, Hot Air in Duct, Changeover in Heating, Thermostat Closed, Controller Bleeding, Unit Heating

VAV HEATING — It is suggested that the following section be reviewed before reading this section: VAV Cooling, page 56.

Combining a diffuser-mounted constant volume control package with a wall-mounted thermostat package (heating only) allows the use of Moduline® units in VAV heating applications.

The operation of the heating only thermostat is opposite to that of the cooling only thermostat in that the heating only thermostat is reverse acting (RA) instead of direct acting (DA). The thermostat's bleed valve is open when the room temperature is above set point. It bleeds air from the low pressure chamber of the volume controller, lowering its pressure, and allowing the relatively stronger pressure of the air in the controller's high pressure chamber to hold closed the bleed from the controller's bellows pressure chamber. The bellows pressure becomes equal to the high pressure in the unit plenum, closing the unit damper and shutting off the unit discharge. See Fig. 66.

As the room temperature falls, the thermostat bleed closes proportionally. This raises the pressure of the air in the low pressure chamber of the controller, forcing the bellows pressure chamber bleed open and lowering the bellows pressure proportionally. The damper opens and the unit delivers air to meet the existing demand in the conditioned space. See Fig. 67.

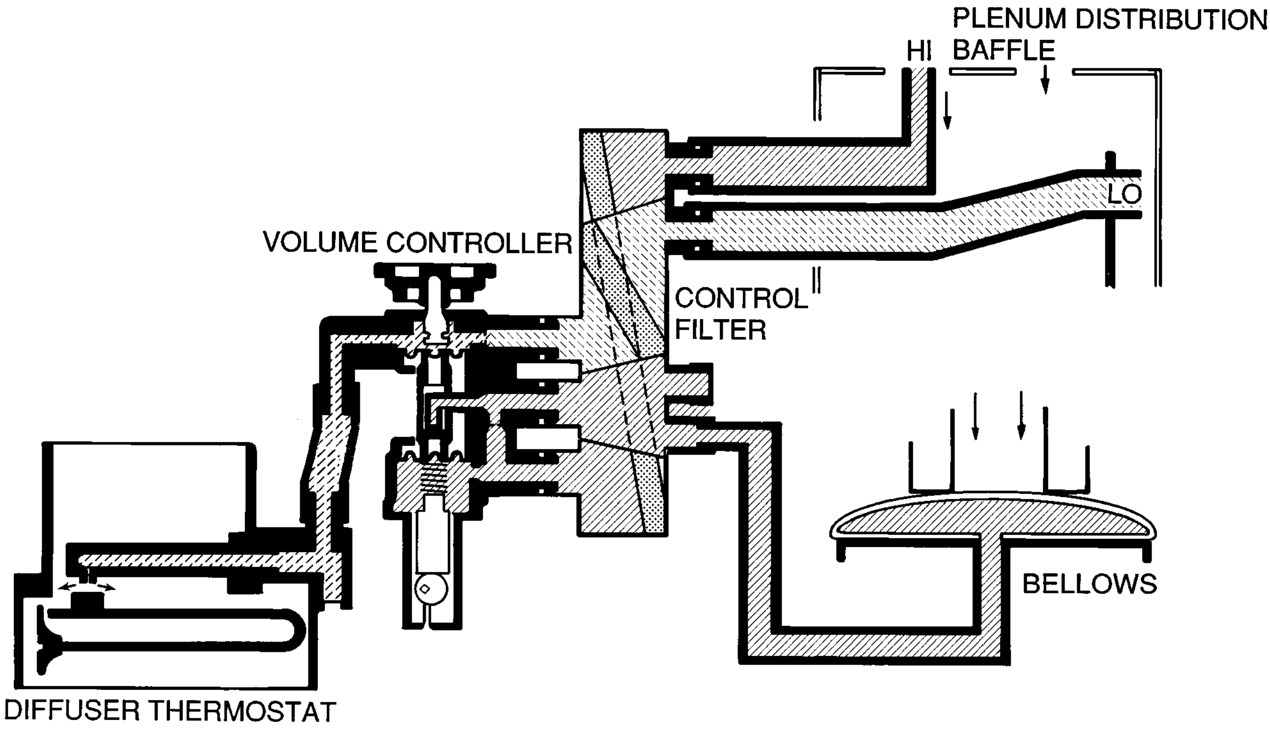


Fig. 66 — Variable Volume Controls — Thermostat Open, Controller Shut Off, Unit Shut Off

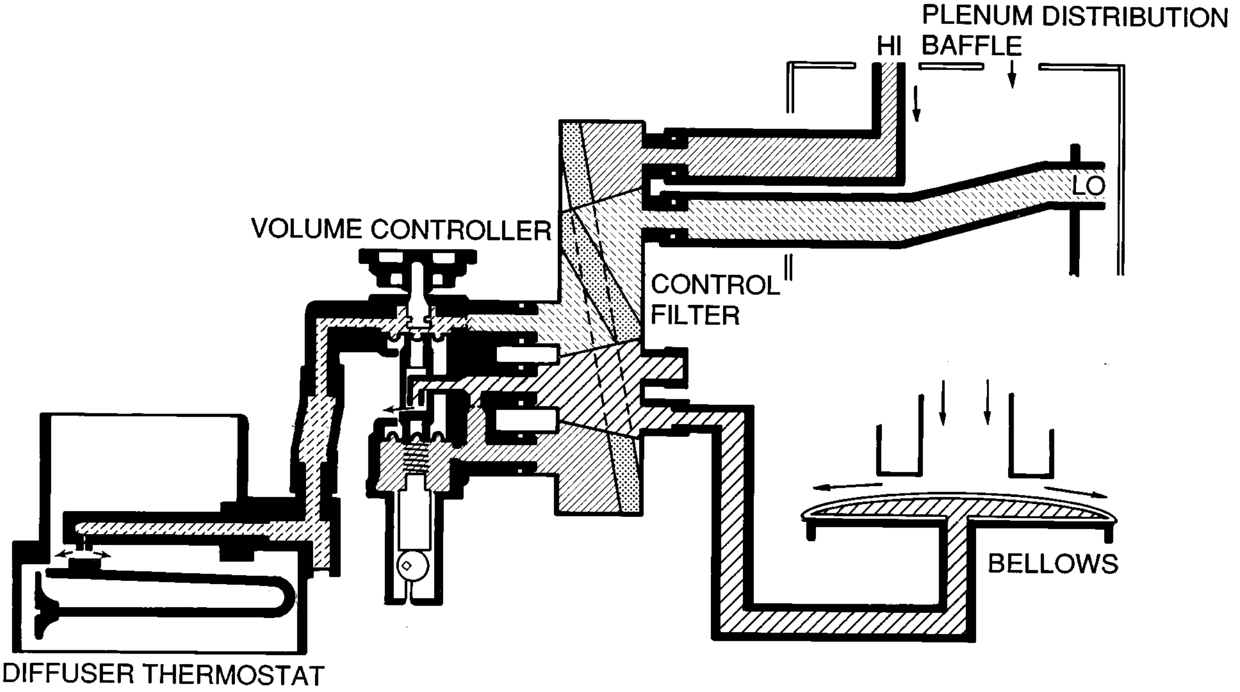


Fig. 67 — Variable Volume Controls — Minimum Flow: Thermostat Partially Open, Controller Partially Open, Unit Delivering Minimum Flow

System-Powered Controls with Electric Interface

VAV COOLING WITH ELECTRIC WARM-UP — Another approach to warm-up is the addition of an electric warm-up valve; the operating principle is the same as system powered warm-up. A building with its conditioning system shut down during unoccupied hours must be brought close to operating temperature before the occupants arrive. Heated air supplied to the space from a central unit can quickly restore operating conditions. But because the VAV thermostat has closed the unit, the result of the lack of load, the system powered control needs to be overcome.

An electric warm-up valve located on the Moduline unit between the volume controller and the thermostat is wired to the primary air source machine room. The valve can be activated by a simple manual or timer switch or it can be connected to the warm-up terminal of the central station unit, if such is provided. Thus, when heated air begins to flow in the distribution duct, the bellows is bled down by the action of the electric warm-up valve and heated air can flow into the conditioned space (Fig. 68).

In the cooling mode (Fig. 69), air flows freely between the volume controller and the thermostat and control function is not affected. When warm-up is activated, the normally open port closes and the control circuit is closed after the volume controller. As with system powered warm-up, this causes the pressure to rise in the low pressure chamber of the volume controller and opens the valve that bleeds air from the bellows pressure chamber. The increased bleed rate lowers the bellows pressure, opening the unit damper, and allowing the flow of primary air to increase up to the constant volume set point of the volume controller.

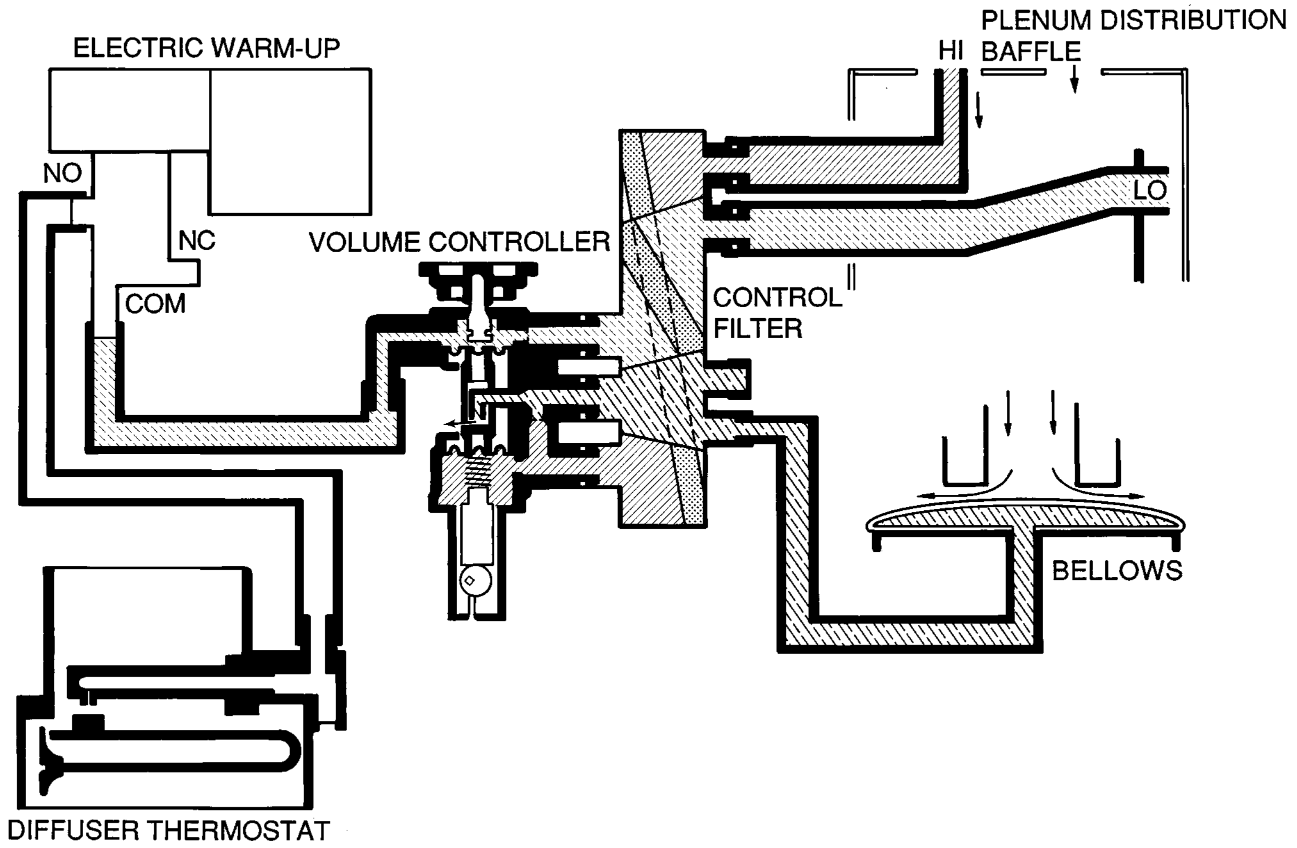


Fig. 68 — Cooling with Warm-Up — Morning, Hot Air in Duct, Warm-Up Switch Closed, Controller Bleeding, Unit Heating

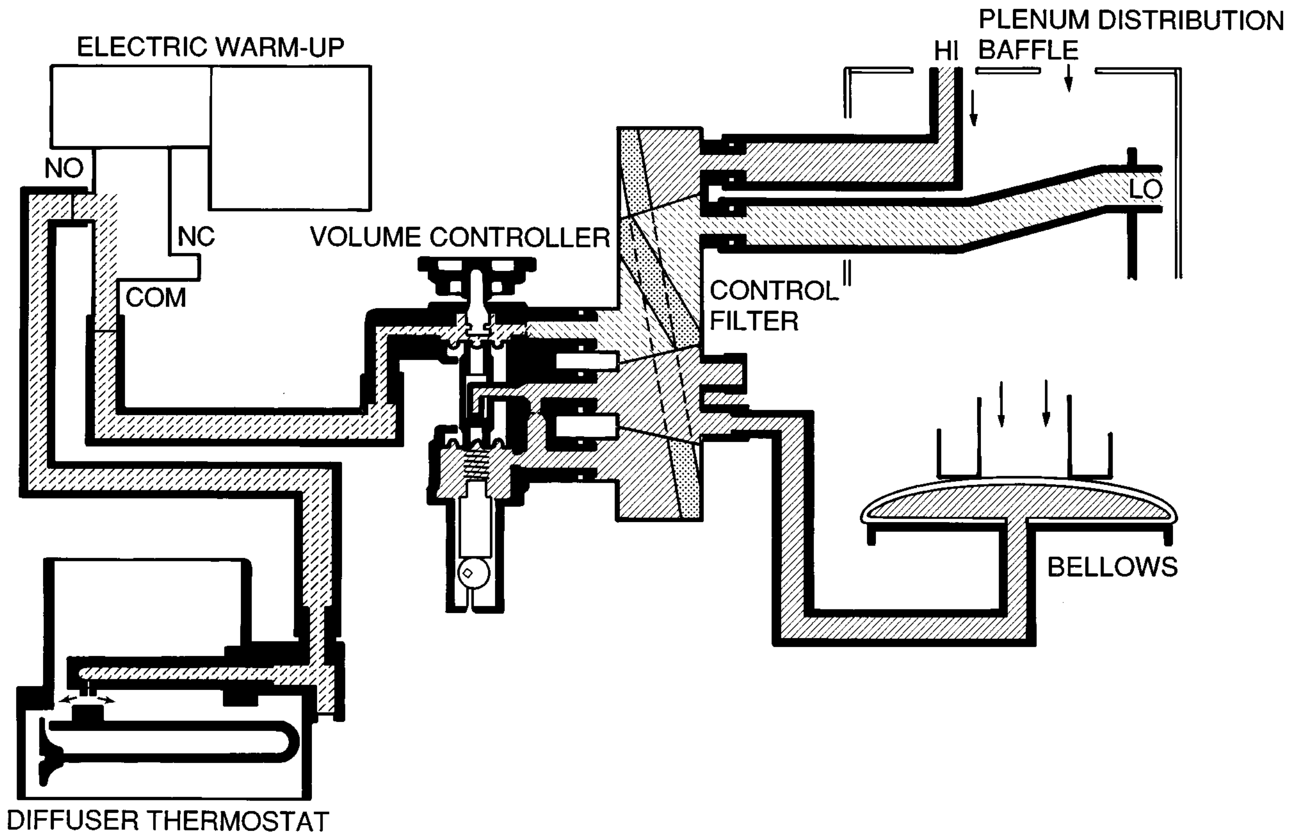


Fig. 69 — Cooling with Warm-Up — Nighttime Condition, Room Cool, Thermostat Open, Bleeding, Warm-Up Open, Controller Shut Off, Unit Shut Off

VAV HEATING AND COOLING WITH ELECTRIC CHANGEOVER — This application uses a CV control package along with a wall-mounted thermostat package (cooling/heating) and an electric changeover package. The changeover valve permits control of the unit to be switched between the cooling and heating sides of a cooling/heating thermostat. It is field-installed in-line between the volume controller and the thermostat.

Refer to Fig. 70-73. In cooling operation, the NO port of the valve opens the control circuit between the volume controller and the cooling side of the thermostat. Because the NC port is closed, the heating side of the thermostat is locked out of the system. Upon changeover to heating, the solenoid valve is energized. The NO port closes and the NC port is opened, and the control circuit switches to the heating side of the thermostat. Typically, the solenoid valve is wired to activate automatically when the heating system is turned on, although it may be operated by a simple on/off switch.

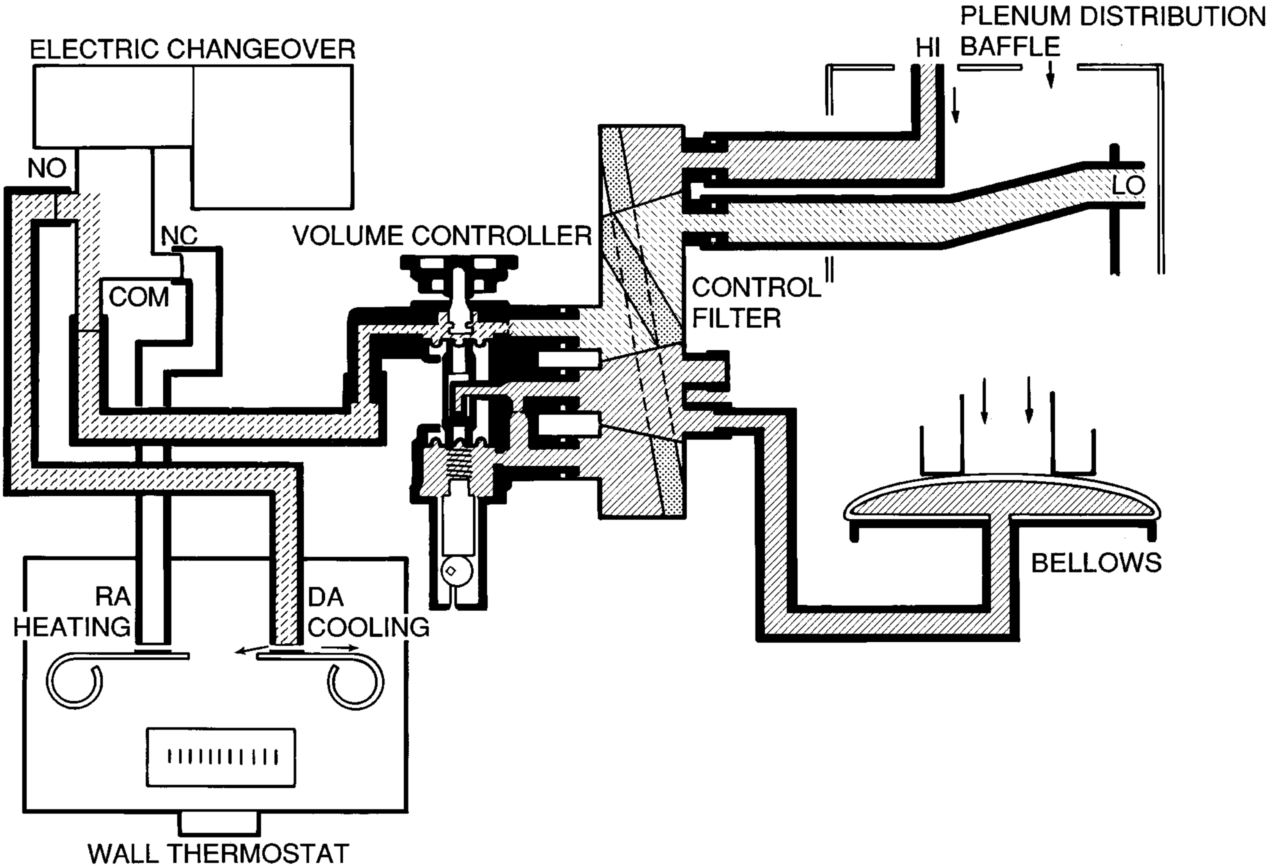


Fig. 70 — Heating/Cooling Unit — Cooling, Cold Air in Duct, Electric Changeover in Cooling, Thermostat Open, Controller Shut Off, Unit Shut Off

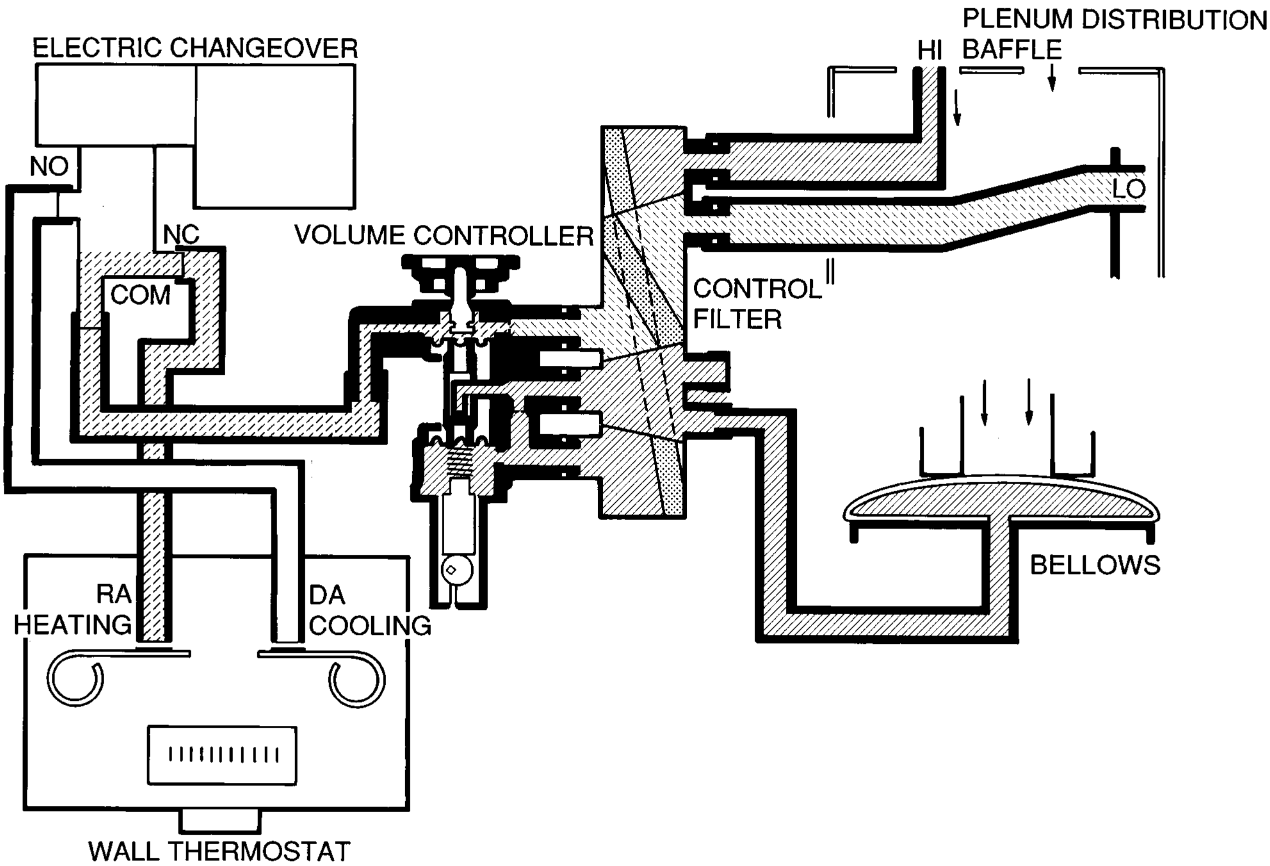


Fig. 71 — Heating/Cooling Unit — Heating, Hot Air in Duct, Electric Changeover in Heating, Thermostat Open, Controller Shut Off, Unit Shut Off

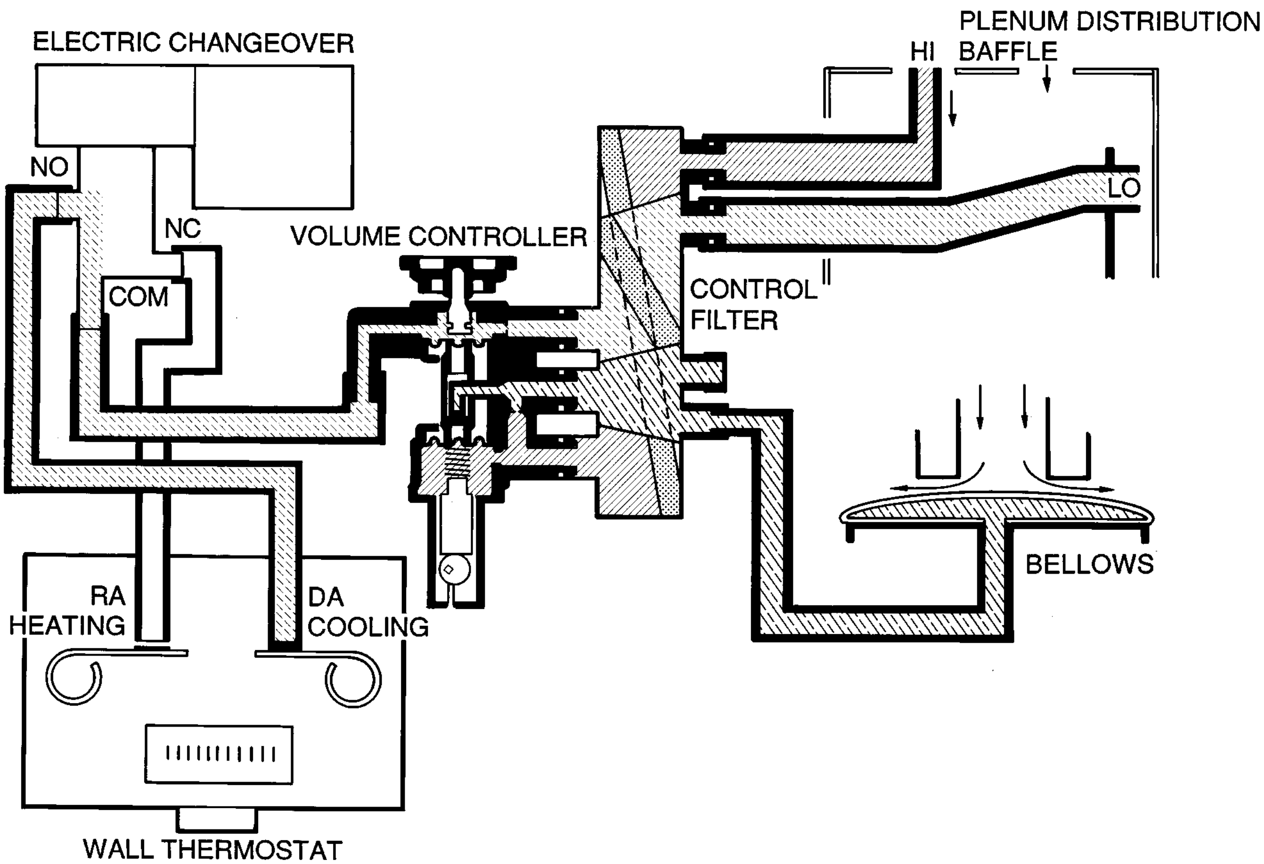


Fig. 72 — Heating/Cooling Unit — Cooling, Cold Air in Duct, Electric Changeover in Cooling, Thermostat Closed, Controller Bleeding, Unit Cooling

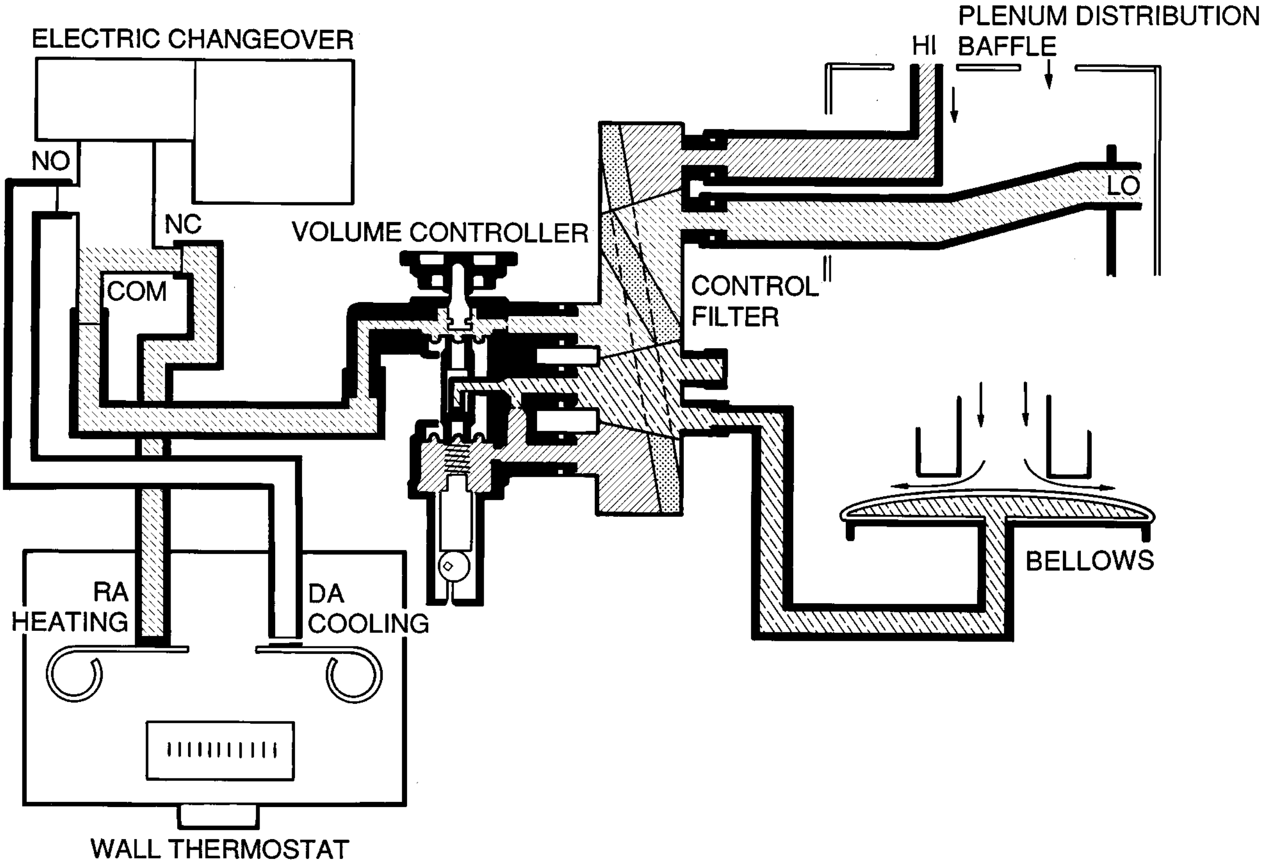


Fig. 73 — Heating/Cooling Unit — Heating, Hot Air in Duct, Electric Changeover in Heating, Thermostat Closed, Controller Bleeding, Unit Heating

VAV COOLING WITH ELECTRIC HEAT INTERLOCK — A conditioned space may contain a Moduline system for cooling and a separate heating system such as baseboard electric or hot water or an overhead fan coil. The electric interlock switch enables the cooling and heating systems to operate as the load dictates with overlap.

The electric interlock switch compares the bellows pressure with the low pressure, as a practical means of detecting the operating level of the unit. When the unit is delivering, the bellows pressure is significantly lower than the low pressure and the electric interlock (differential pressure) switch is open, interrupting the power supply to the heating system. When the unit is shut off, the pressures are approximately equal and the switch closes, allowing the heating system to be energized. It is field installed with the low pressure port piped to the auxiliary bellows pressure stub of the filter. (See Fig. 74.) The high pressure port is connected by a “T” into the line between the volume regulator and the thermostat.

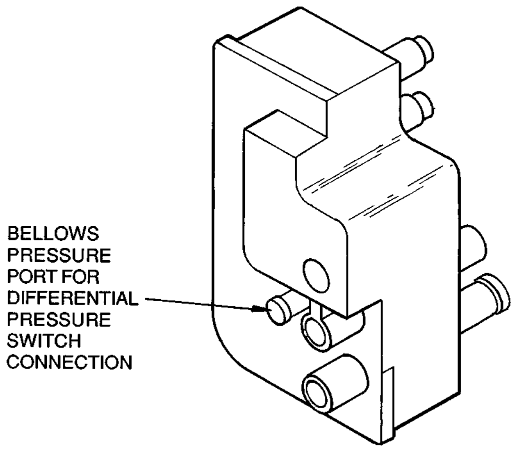


Fig. 74 — Connection for Electric Interlock

System-Powered Controls with Pneumatic Interface

PNEUMATIC SEQUENCED HEATING/COOLING (HOT WATER) — By using a 20 psi pneumatic source, one thermostat can control both heating and Moduline cooling in the conditioned space. The pneumatic circuit is interfaced with the system-powered circuit by use of a pilot valve. In cooling, the Moduline airflow is controlled by the duct-powered volume controller just as in all system-powered control. As the schematic diagram shows, a DA pneumatic wall thermostat working through the pilot valve, replacing the system-powered thermostat, modulates the pilot valve and thus the volume controller low side pressure.

Figure 75 shows the piping diagram. Figure 76 shows the sequence diagram for a direct acting thermostat with a normally open pilot valve. With the system shut down and the space temperature low, at start-up the thermostat branch pressure is low, and the normally open water valve (or other heating means) is open. As the space temperature rises, the branch pressure rises, modulating the water valve to a closed position. The pilot valve is normally open, with set point above water valve spring rate, thus maintaining a low pressure in the low side of the volume controller, closing the bleed valve in the controller and raising the bellows pressure to the duct pressure level; this results in unit shutoff.

If the space temperature continues to rise, the NO pilot valve will modulate toward closed, raising the low side pressure, opening the bleed, reducing the bellows pressure, and opening the Moduline unit air valve. The airflow will rise until the volume controller setting is reached.

Note that the spring rates of the hot water valve and the pilot valve must be properly matched to accomplish the action described above.

A heating/cooling sequence can also be accomplished with a reverse acting circuit (Fig. 77 and 78). At start-up, the temperature is low, the branch pressure is high, and normally closed water valve is wide open. As the space temperature rises, the branch pressure falls and the water valve closes, stopping the heating supply. The pilot valve is NC and thus at branch pressures above its setting will open, volume controller low pressure will be reduced, the bellows pressure will rise and the unit will shut off.

LEGEND FOR FIG. 75 - 78

DA	Direct Acting	**NC**	Normally Closed
HW	Hot Water	**NO**	Normally Open
M	Main	**RA**	Reverse Acting

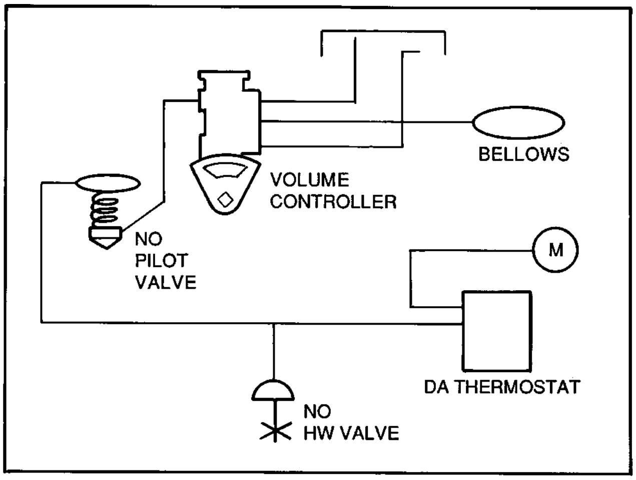


Fig. 75 — Piping Diagram, Heating/Cooling Sequence, DA Thermostat

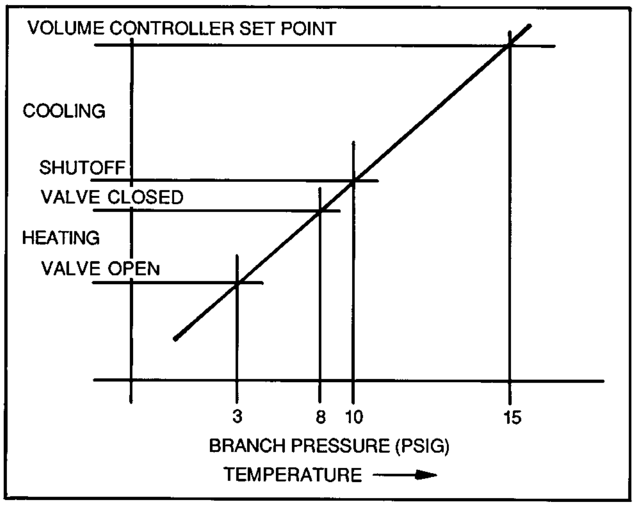


Fig. 76 — Sequence Diagram — DA Thermostat

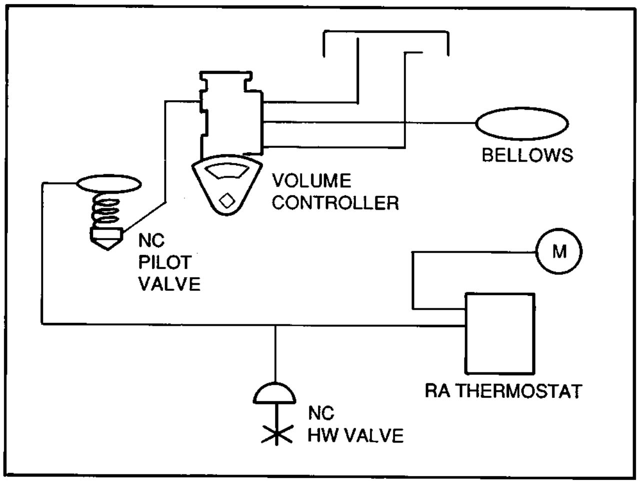


Fig. 77 — Piping Diagram, Heating/Cooling Sequence, RA Thermostat

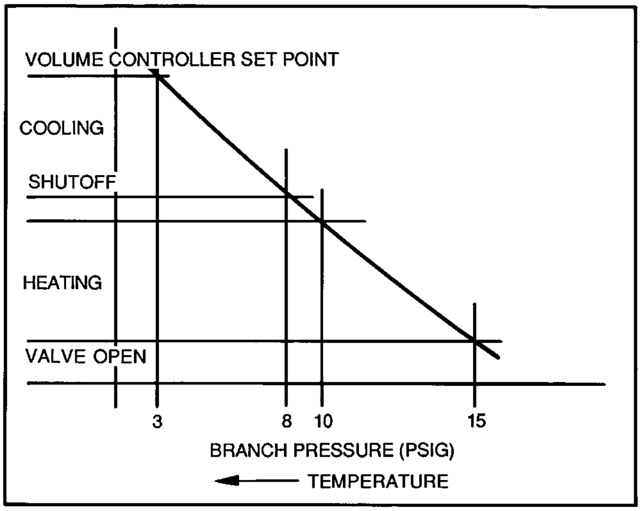


Fig. 78 — Sequence Diagram, RA Thermostat

VAV COOLING WITH PNEUMATIC WARM-UP OR FIRE SAFETY SWITCH — Through the use of a specific pneumatic switch, the functions of pneumatic warm-up and fire safety can be added to Moduline® installations.

Pneumatic warm-up offers an opportunity to open all Moduline units in an area to allow immediate hot air distribution prior to the building occupancy. Through the use of a separate pneumatic signal, the pneumatic warm-up switch, placed in-line between the Moduline volume controller and the diffuser or wall system powered thermostat, closes the low pressure bleed in the thermostat line (in the same way as the system powered warm-up switch). This raises the low side pressure, opens the volume controller bleed and lowers the bellows pressure, allowing airflow from the Moduline terminal at the setting of the volume controller.

The pneumatic warm-up switch can be piped either NO or NC. Figure 79 shows an NO arrangement. The switch is nonadjustable and preset to close at 8 ± 2.0 psig. Thus a signal pressure in excess of 10 psi will cause the switch to close. A pneumatic warm-up switch is required for each Moduline unit but only one pneumatic signal valve is required for multiple Moduline units. Figure 80 shows the basic piping.

The field-supplied 3-way pneumatic valve is supplied with main pressure and is closed in cooling operation. When heat for warm-up is required, a signal sent from the heat source opens the pneumatic valve, supplying main pressure to the Moduline pneumatic warm-up switches. When the heat is discontinued, the pneumatic valve opens and the switches return to an open configuration.

Note that the pneumatic warm-up switch is a nonbleed device. The pneumatic valve should therefore be a 3-way device, arranged to bleed out the pneumatic circuit downstream of the valve when the valve is closed.

The pneumatic warm-up switch can be arranged as an NC device; Fig. 81 gives the piping connections.

For fire safety, the same switch is added to the Moduline control circuit as a normally open fire safety switch as shown in Fig. 82A. The fire safety switch on each Moduline terminal is connected to a pneumatic distribution circuit on each floor of the building. A 3-way valve is connected to the switches and to the fire master control as shown in Fig. 83.

The operation is identical to the pneumatic warm-up circuit. At the onset of a fire, the fire master control opens the Moduline units on the non-fire floors by closing the Moduline fire safety switches, raising the controller low side pressure and bleeding the bellows. The 3-way pneumatic valve on each floor supplies pneumatic pressure in excess of the set point of 8.0 ± 2 psig. On the fire floor where air is to be shut down, the distribution system uses a duct fire-damper to stop the air, and the fire safety switch position is not the determining factor in the Moduline operation.

If a normally closed fire switch is required, see piping diagram shown in Fig. 82B. In this case, pneumatic pressure is maintained on the fire switch when the system fan is activated. Loss of pneumatic pressure closes the fire switch, bleeding the bellows.

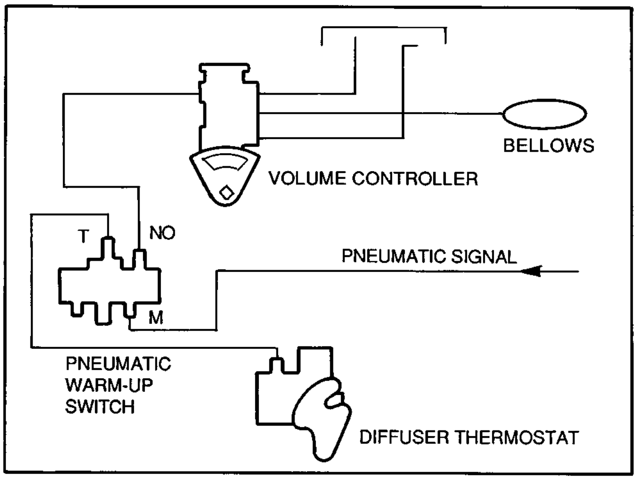


Fig. 79 — Piping Diagram, NO Configuration, Pneumatic Warm-Up

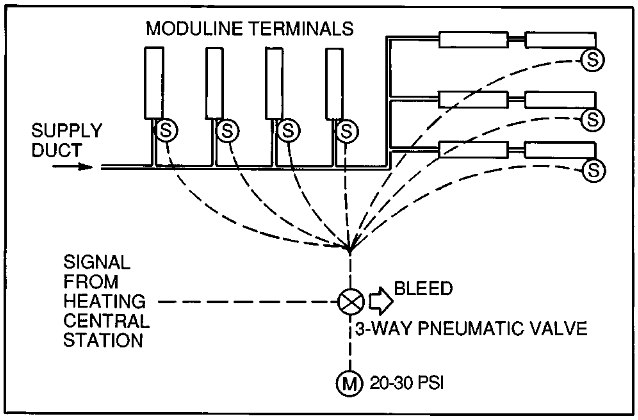


Fig. 80 — Basic Piping for Pneumatic Warm-Up Switch

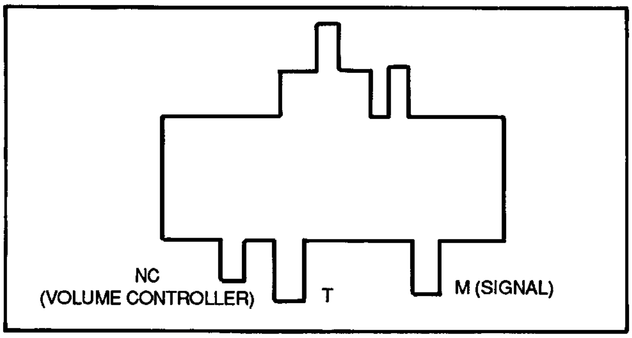


Fig. 81 — Piping Diagram, NC Configuration, Pneumatic Warm-Up

LEGEND FOR FIG. 79 - 83

HW	— Hot Water	**NO**	— Normally Open
M	— Main	**S**	— Switch
NC	— Normally Closed	**T**	— Thermostat

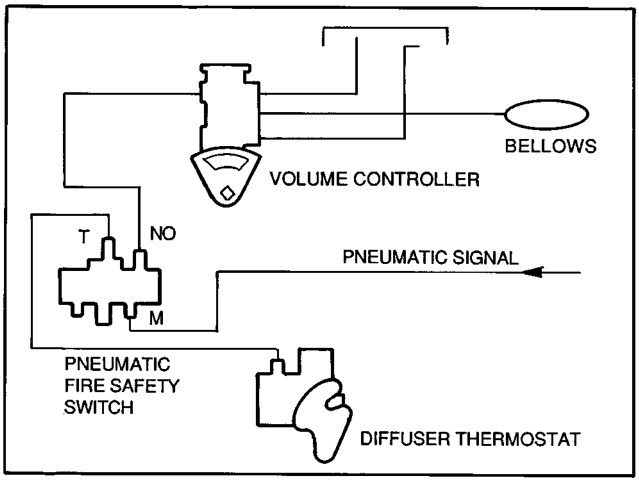


Fig. 82A — NO Configuration for Fire Safety

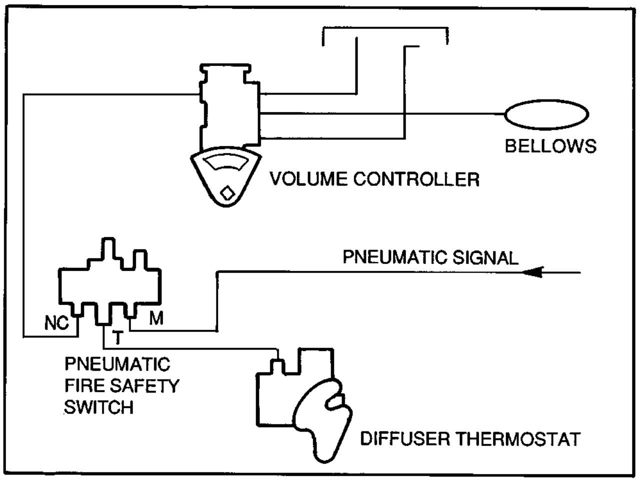


Fig. 82B — NC Configuration for Fire Safety

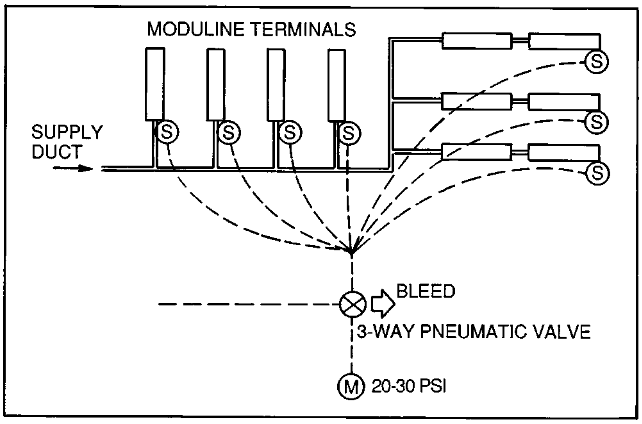


Fig. 83 — Fire Safety Switch Floor Layout

AIRFLOW ADJUSTMENT

Each 37HS volume controller is equipped with a maximum cfm lever for setting the required unit airflow in the field. The lever is located at the bottom of the controller. See Fig. 84. The controller has a star wheel located at the top of the controller for setting the minimum airflow. The star wheel is also shown in Fig. 84.

Maximum Airflow (Cfm) Adjustment — The 37HS maximum airflow adjustment lever is common to all sizes and is divided into levels of percent cfm. Table 16 shows the unit airflow that will be obtained by each lever setting for each unit size.

Table 16 — Maximum Airflow Settings

LEVER SETTING (% CFM)	UNIT AIRFLOW (CFM)		
	37HS1	37HS2	37HS4
120	120	240	480
100	100	200	400
80	80	160	320
40	40	80	160

The maximum cfm is the unit airflow obtained when the thermostat is calling for full cooling in a VAV system; it is the design cfm for the space conditioned by the unit or units regulated by one controller.

To set maximum cfm with zero minimum cfm:

1. Set diffuser or wall thermostat for maximum cooling.
2. Turn the minimum cfm star wheel counterlockwise until the internal stop is reached. Do not attempt to override stop. (Minimum cfm has been set at zero, and the unit will turn off when required.)
3. Adjust maximum cfm lever to desired percent cfm.

Minimum Airflow (Cfm) Adjustment — Some applications require both a design maximum cfm and a minimum cfm. The 37HS controller can be set to provide both airflow requirements.

To set maximum and minimum cfm:

1. Set diffuser or wall thermostat for maximum cooling.
2. Turn the minimum cfm star wheel counterclockwise until the internal stop is reached. Do not attempt to override stop.
3. Shut off unit by adjusting thermostat to zero cooling, or disconnect tube from volume controller to thermostat.
4. Place a standard airflow hood against the outlet of the master unit and slowly turn the minimum cfm star wheel on the controller clockwise until the desired minimum cfm is reached.
5. Return the thermostat to the desired setting and/or reconnect tube between volume controller and thermostat.
6. Adjust maximum cfm lever to desired percent cfm.

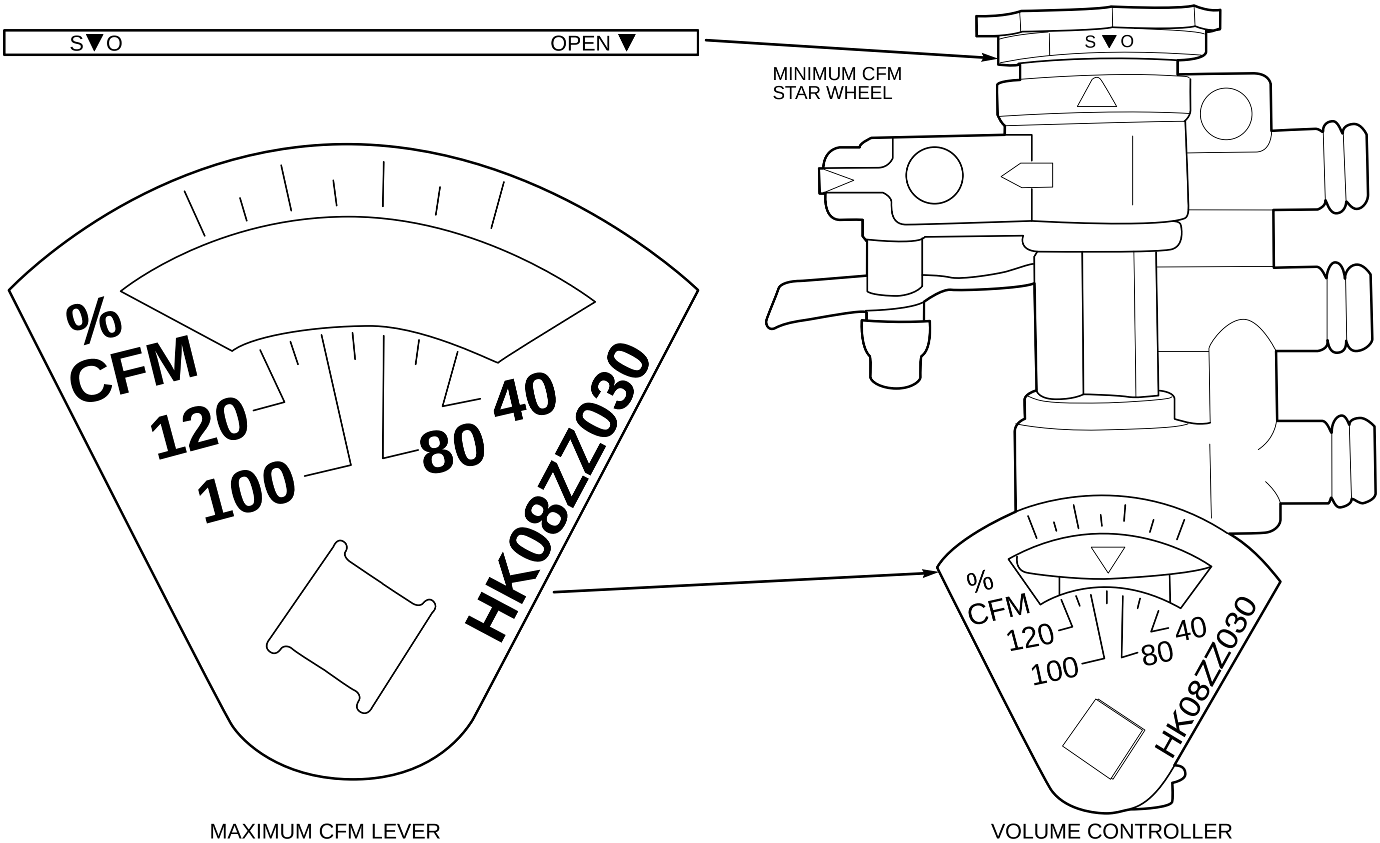


Fig. 84 — Minimum and Maximum Airflow Adjustments, 37HS Controller

Variation in Maximum Airflow — As explained in the Terminal Selection and Layout section, Moduline® units in air series can be controlled individually with a volume controller at each unit, or with a master/slave combination, where one controller is used with multiple units. All the units on one controller must be of the same model (capacity).

In master/slave combinations, some variation in maximum airflow among the terminals in air series will occur. The variation in maximum airflow is a function of the unit plenum size, the model, and the number of units in an air series on one controller. Table 17 shows the expected variation from the unit with the smallest airflow to the unit with the largest airflow.

For single units with controller, the cfm variation from the lever setting is ± 10%.

Table 17 — Multiple Unit Airflow Variation

MODEL	PLENUM SIZE (in.)	APPROXIMATE AIRFLOW VARIATION (Cfm) LOWEST UNIT TO HIGHEST UNIT IN AIR SERIES*			
		Number of Units in Air Series On One Controller			
		2	3	4	5
37HS1	7 x 7	10	15	20	—
	9 x 9	10	15	20	25
	11 x 11	10	15	20	25
37HS2	7 x 7	20	—	—	—
	9 x 9	20	30	40	—
	11 x 11	20	30	40	—
37HS4	9 x 9	40	—	—	—
	11 x 11	40	60	—	—
	13 x 13	40	60	80	—

*Values shown are based on a typical short, straight duct run between units. Variation shown may be affected if there are excessive duct pressure losses between units.

NOTE: The variation value shown in Table 17 for a given number of units of a certain model size (capacity) is the same for all size plenums used in an air series of recommended combinations for that model size. Thus, 3 units of model size 37HS2, plenum size 9 x 9, will have a maximum variation of 30 cfm; 3 units, plenum sizes 9 x 9 (2) and 7 x 7 (1) will also have a maximum variation of 30 cfm. A dash indicates that the quantity of a particular plenum size is not recommended in air series for that unit size.

AIR DISTRIBUTION

Linear slot diffusers are an integral part of the Moduline unit. They provide excellent air distribution for the conditioned space. The diffuser configuration is designed to induce room air, creating continuous air motion for occupants of the room and reasonably consistent temperatures from floor to ceiling.

Figure 85 shows how cool primary air discharged at the ceiling line induces room air toward the diffuser. The cool air mixes with the room air, creating room air motion and raising the temperature of the air descending upon the room occupants. Figure 86 provides a typical room air distribution pattern for 2-way blow and one-way blow Moduline units. The upper number on the distribution pattern is the mixture temperature; the lower number is the air velocity in ft/min.

A variety of diffuser assemblies are available for the Moduline unit. Tables 18 - 20 show the standard diffusers available, which can be ordered directly from the price pages. Tables 21-23 show the optional diffusers, which can be provided by quote control.

The difference in standard 37HS diffusers and optional 37A diffusers is demonstrated in Fig. 87. The slot opening in the 37HS is larger than that of the 37A, reducing the net pressure required from the unit and somewhat reducing the throw.

Note that the dimensions of the diffuser shown in Fig. 87 are useful when matching units or 35BD boot diffusers in the ceiling. Certified dimension drawings are available for these diffusers and the other optional diffusers shown in Tables 21-23.

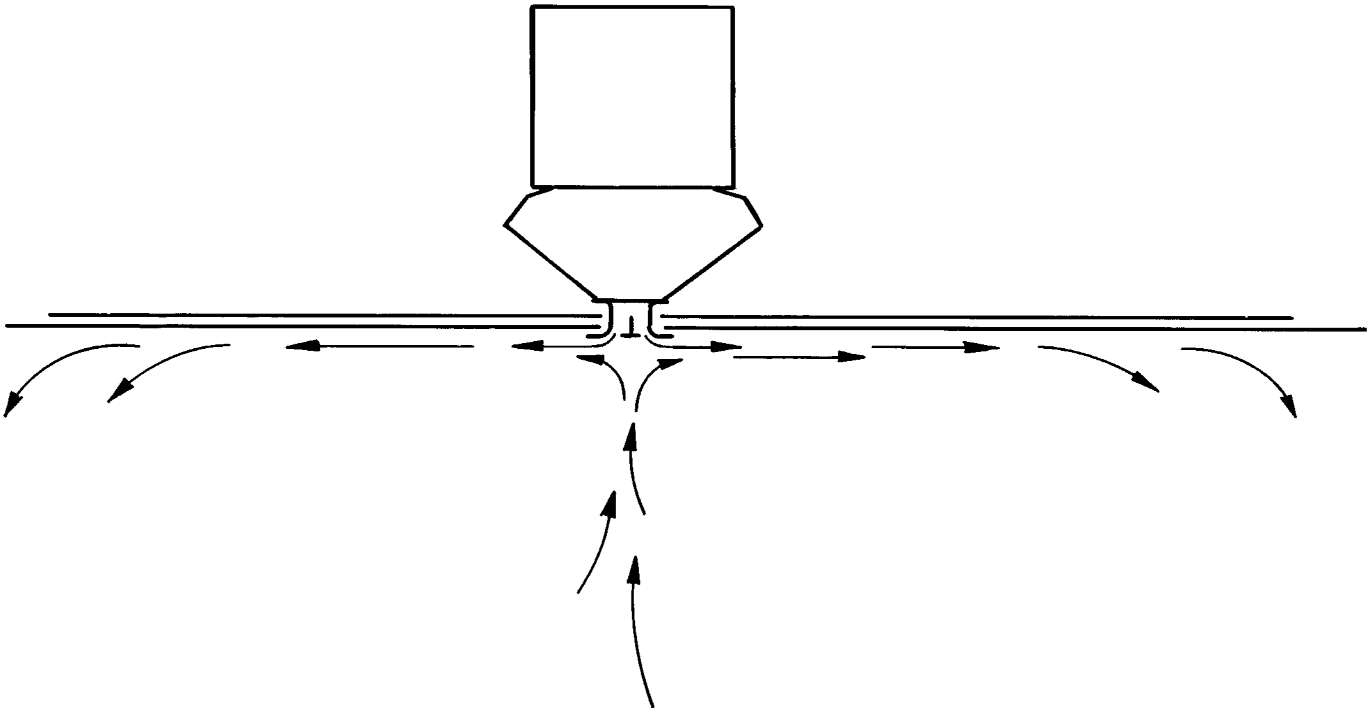
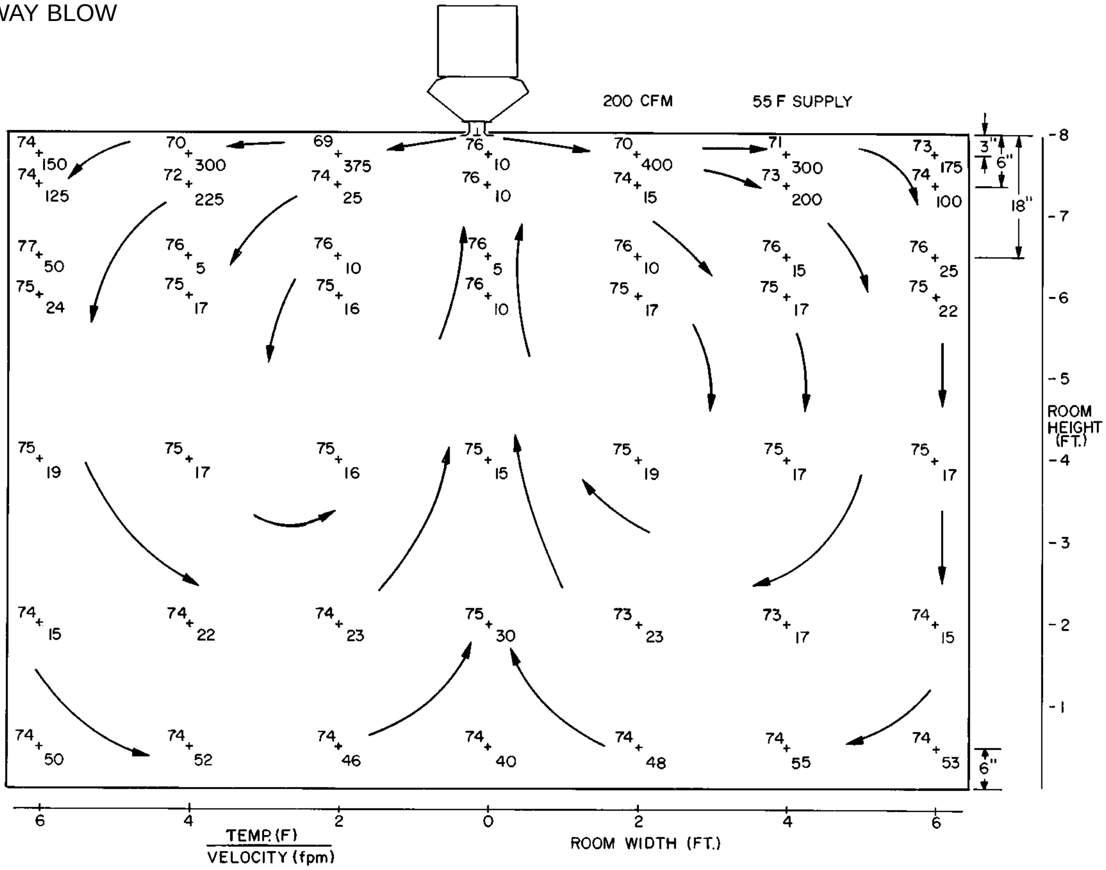


Fig. 85 — Moduline® Diffuser Mixing Room Air and Primary Air

37HS — 2-WAY BLOW



37HS2 — ONE-WAY BLOW

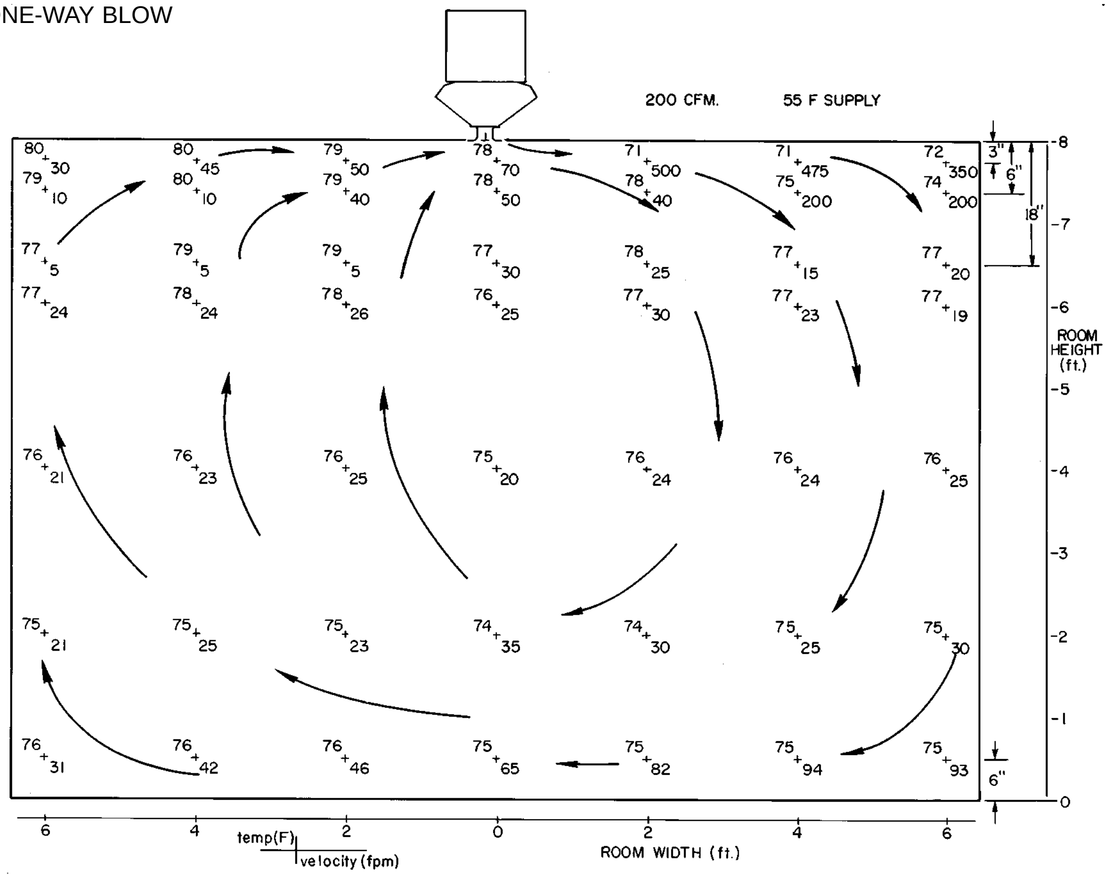


Fig. 86 — Typical Room Air Distribution Pattern

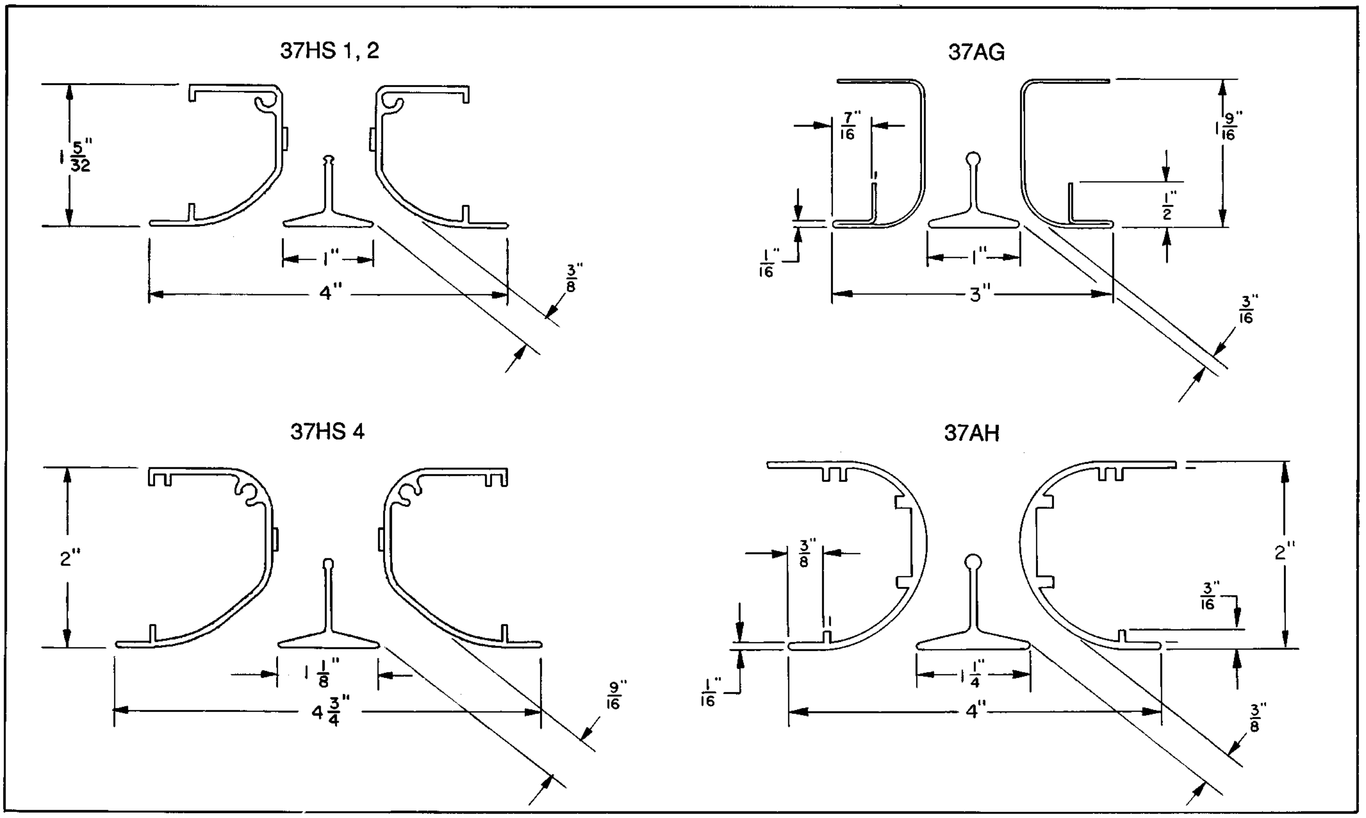


Fig. 87 — Slot Openings in Standard and Optional Diffusers

Table 18 — Standard Diffusers for 37HS1

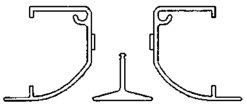
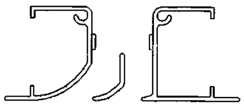
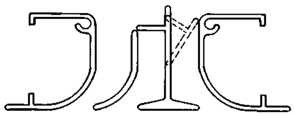
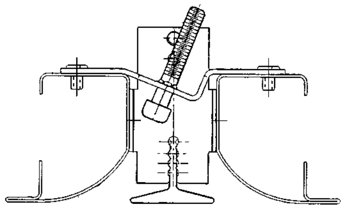
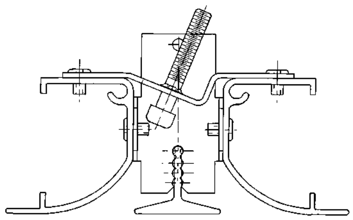
UNIT MODEL	DESIGNATION	CONFIGURATION	FLOW	MATERIAL	MODE	LENGTH (in.)	CEILING TYPE
37HS1	HS		2-Way	Alum	Cooling	23	T-Bar
						47	
						22.92	Tegular T-Bar
						46.92	
						24	Continuous T-Bar
						48	
						23.38	Narrow T-Bar
						47.38	
						1174 mm	Metric
						1200 mm	
			One-Way	Alum	Cooling	23	T-Bar
						47	
						22.92	Tegular T-Bar
						46.92	
						24	Continuous T-Bar
						48	
						23.38	Narrow T-Bar
						47.38	
						1174 mm	Metric
						1200 mm	
		 DIRECTOR DIFFUSER	Two-Way or One-Way	Alum	Heating Cooling	23	T-Bar
						22.92	Tegular T-Bar
						24	Continous T-Bar
						23.38	Narrow T-Bar
		 REMOVABLE DIFFUSER	2-Way	Steel	Cooling	23	Plaster, Spline
						47	
						22.92	
						46.92	
						24	
						48	
						23.38	
						47.38	
						1174 mm	Metric
						1200 mm	
		 REMOVABLE DIFFUSER	2-Way	Alum	Cooling	23	Plaster, Spline
						47	
						22.92	
						46.92	
						24	
						48	
						23.38	
						47.38	
						1174 mm	Metric
						1200 mm	

Table 19 — Standard Diffusers for 37HS2

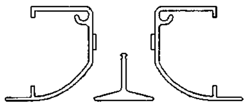
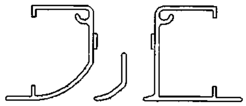
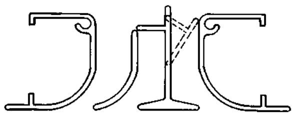
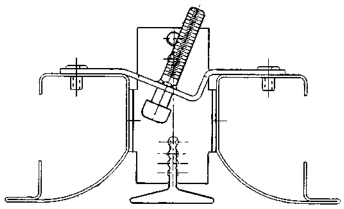
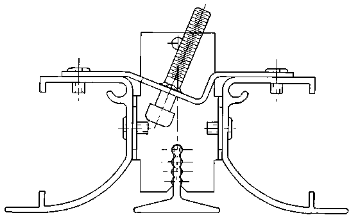
UNIT MODEL	DESIGNATION	CONFIGURATION	FLOW	MATERIAL	MODE	LENGTH (in.)	CEILING TYPE
37HS2	HS		2-Way	Alum	Cooling	47	T-Bar
						59	
						46.92	Tegular T-Bar
						58.92	
						48	Continuous T-Bar
						60	
						47.38	Narrow T-Bar
						59.38	
						1174 mm	Metric
						1200 mm	
			One-Way	Alum	Cooling	47	T-Bar
						59	
						46.92	Tegular T-Bar
						58.92	
						48	Continuous T-Bar
						60	
						47.38	Narrow T-Bar
						59.38	
						1174 mm	Metric
						1200 mm	
		 DIRECTOR DIFFUSER	2-Way or One-Way	Alum	Heating Cooling	47	T-Bar
						59	
						46.92	Tegular T-Bar
						58.92	
						48	Continuous T-Bar
						60	
						47.38	Narrow T-Bar
						59.38	
						1174 mm	Metric
						1200 mm	
		 REMOVABLE DIFFUSER	2-Way	Steel	Cooling	47	Plaster, Spline
						59	
						46.92	
						58.92	
						48	
						60	
						47.38	
						59.38	
						1174 mm	Metric
						1200 mm	
		 REMOVABLE DIFFUSER	2-Way	Alum	Cooling	47	Plaster, Spline
						59	
						46.92	
						58.92	
						48	
						60	
						47.38	
						59.38	
						1174 mm	Metric
						1200 mm	

Table 20 — Standard Diffusers for 37HS4

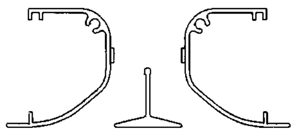
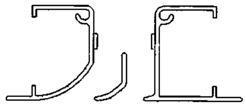
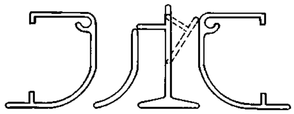
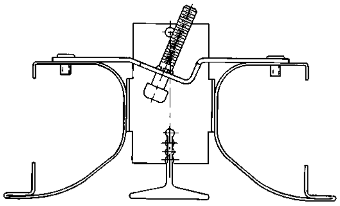
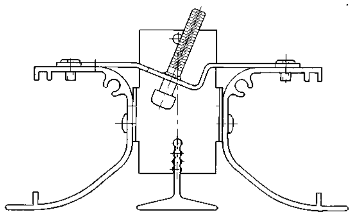
UNIT MODEL	DESIGNATION	CONFIGURATION	FLOW	MATERIAL	MODE	LENGTH (in.)	CEILING TYPE
37HS4	HS		2-Way	Alum	Cooling	47	T-Bar
						59	
						46.92	Tegular T-Bar
						58.92	
						48	Continuous T-Bar
						60	
						47.38	Narrow T-Bar
						59.38	
						1174 mm	Metric
						1200 mm	
			One-Way	Alum	Cooling	47	T-Bar
						59	
						46.92	Tegular T-Bar
						58.92	
						48	Continuous T-Bar
						60	
						47.38	Narrow T-Bar
						59.38	
						1174 mm	Metric
						1200 mm	
		 DIRECTOR DIFFUSER	2-Way or One-Way	Alum	Heating Cooling	47	T-Bar
						59	
						46.92	Tegular T-Bar
						58.92	
						48	Continuous T-Bar
						60	
						47.38	Narrow T-Bar
						59.38	
						1174 mm	Metric
						1200 mm	
		 REMOVABLE DIFFUSER	2-Way	Steel	Cooling	47	Plaster, Spline
						59	
						46.92	
						58.92	
						48	
						60	
						47.38	
						59.38	
						1174 mm	Metric
						1200 mm	
		 REMOVABLE DIFFUSER	2-Way	Alum	Cooling	47	Plaster, Spline
						59	
						46.92	
						58.92	
						48	
						60	
						47.38	
						59.38	
						1174 mm	Metric
						1200 mm	

Table 21 — Optional Diffusers for 37HS1

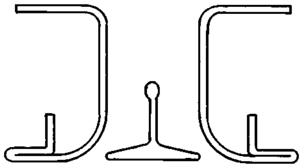
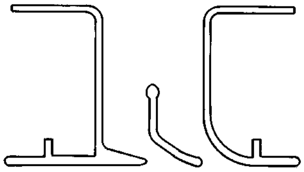
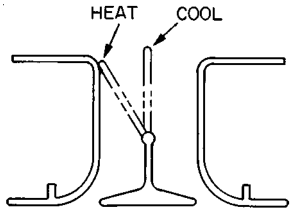
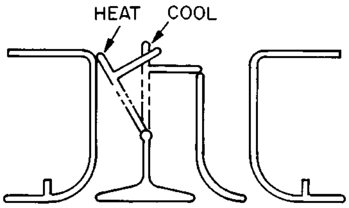
UNIT MODEL	DESIGNATION	CONFIGURATION	FLOW	MATERIAL	MODE	LENGTH (in.)	CEILING TYPE
37HS1	AG		2-Way	Alum	Cooling	23	T-Bar
						47	
						22.92	Tegular T-Bar
						46.92	
						24	Continuous T-Bar
						48	
						23.38	Narrow T-Bar
						47.38	
						1174 mm	Metric
						1200 mm	
	AG		One-Way	Alum	Cooling	23	T-Bar
						47	
						22.92	Tegular T-Bar
						46.92	
						24	Continuous T-Bar
						48	
						23.38	Narrow T-Bar
						47.38	
						1174 mm	Metric
						1200 mm	
	DG		2-Way or One-Way; 2-Slot	Alum	Heating Cooling	23	T-Bar
						22.92	Tegular T-Bar
						24	Continuous T-Bar
						23.38	Narrow T-Bar
	DG		2-Way or One-Way; 3-Slot	Alum	Heating Cooling	23	T-Bar
						22.92	Tegular T-Bar
						24	Continuous T-Bar
						23.38	Narrow T-Bar

Table 22 — Optional Diffusers for 37HS2

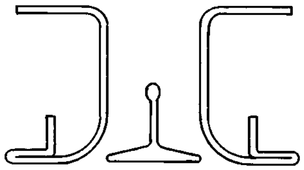
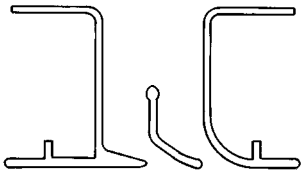
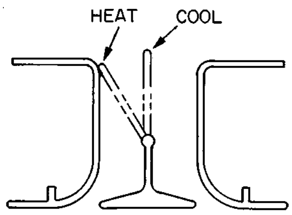
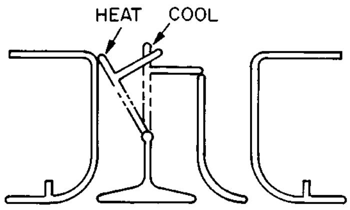
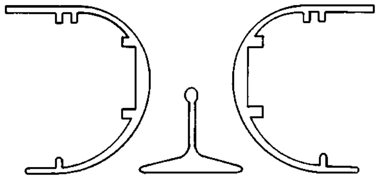
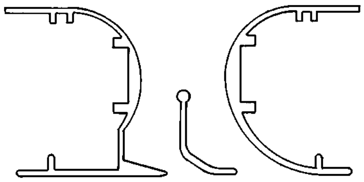
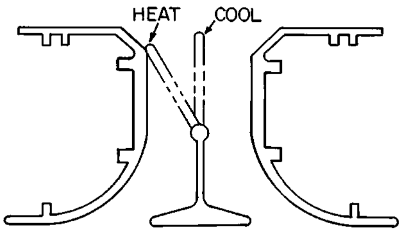
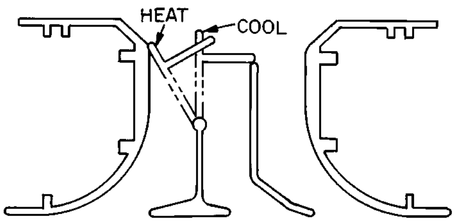
UNIT MODEL	DESIGNATION	CONFIGURATION	FLOW	MATERIAL	MODE	LENGTH (in.)	CEILING TYPE
37HS2	AG		2-Way	Alum	Cooling	47 59	T-Bar
						46.92 58.92	Tegular T-Bar
						48 60	Continuous T-Bar
						47.38 59.38	Narrow T-Bar
						1174 mm 1200 mm	Metric
	AG		One-Way	Alum	Cooling	47 59	T- Bar
						46.92 58.92	Tegular T-Bar
						48 60	Continuous T-Bar
						47.38 59.38	Narrow T-Bar
						1174 mm 1200 mm	Metric
	DG	 DIRECTOR DIFFUSER	2-Way or One-Way; 2-Slot	Alum	Heating Cooling	47 59	T-Bar
						46.92 58.92	Tegular T-Bar
						48 60	Continuous T-Bar
						47.38 59.38	Narrow T-Bar
						1174 mm 1200 mm	Metric
	DG	 DIRECTOR DIFFUSER	2-Way or One-Way; 3-Slot	Alum	Heating Cooling	47 59	T-Bar
						46.92 58.92	Tegular T-Bar
						48 60	Continuous T-Bar
						47.38 59.38	Narrow T-Bar
						1174 mm 1200 mm	Metric

Table 23 — Optional Diffusers for 37HS4

UNIT MODEL	DESIGNATION	CONFIGURATION	FLOW	MATERIAL	MODE	LENGTH (in.)	CEILING TYPE
37HS4	AH		2-Way	Alum	Cooling	47	T-Bar
						59	
						46.92	Tegular T-Bar
						58.92	
						48	Continuous T-Bar
						60	
						47.38	Narrow T-Bar
						59.38	
						1174 mm	Metric
						1200 mm	
	AH		One-Way	Alum	Cooling	47	T-Bar
						59	
						46.92	Tegular T-Bar
						58.92	
						48	Continuous T-Bar
						60	
						47.38	Narrow T-Bar
						59.38	
						1174 mm	Metric
						1200 mm	
	DH	 DIRECTOR DIFFUSER	2-Way or One-Way	alum	Heating Cooling	47	T-Bar
						59	
						46.92	Tegular T-Bar
						58.92	
						48	Continuous T-Bar
						60	
						47.38	Narrow T-Bar
						59.38	
						1174 mm	Metric
						1200 mm	
	DH	 DIRECTOR DIFFUSER	2-Way	Alum	Heating Cooling	47	T-Bar
						59	
						46.92	Tegular T-Bar
						58.92	
						48	Continuous T-Bar
						60	
						47.38	Narrow T-Bar
						59.38	
						1174 mm	Metric
						1200 mm	

Throw for Standard Diffusers — Tables 24 and 25 provide the suggested minimum and maximum coverages the Moduline® air terminals can handle in a typical installation while maintaining the desired room conditions.

The optimum air throw values given in the table are distances from the unit centerline to the outside wall or nearest obstruction (wall, light fixture or opposing air stream).

Table 24 — Air Throw Data — 1-Way and 2-Way Blow, 2-Slot Diffusers

37HS1 UNIT AIRFLOW (Cfm)	OPTIMUM AIR THROW (ft)			
	1-Way Blow		2-Way Blow	
	Min	Max	Min	Max
40	2.0	7.0	2.0	5.0
50	4.0	9.0	3.0	6.0
60	7.5	12.0	3.5	7.5
70	8.0	15.0	4.0	9.0
80	9.0	18.0	4.5	10.5
90	10.0	20.0	5.0	11.5
100	11.0	22.0	6.0	13.0
110	12.0	24.0	7.0	15.0

37HS2 UNIT AIRFLOW (Cfm)	OPTIMUM AIR THROW (ft)			
	1-Way Blow		2-Way Blow	
	Min	Max	Min	Max
80	2.0	7.0	2.0	5.0
100	4.0	9.0	3.0	6.0
120	7.5	12.0	3.5	7.5
140	8.0	15.0	4.0	9.0
160	9.0	18.0	4.5	10.5
180	10.0	20.0	5.0	11.5
200	11.0	22.0	6.0	13.0
220	12.0	24.0	7.0	15.0

37HS4 UNIT AIRFLOW (Cfm)	OPTIMUM AIR THROW (ft)			
	1-Way Blow		2-Way Blow	
	Min	Max	Min	Max
160	8.5	16.0	5.0	7.0
200	10.0	20.0	6.0	10.0
250	11.0	21.0	7.0	13.0
300	12.0	22.0	8.0	17.0
350	14.0	23.0	9.0	19.0
400	15.0	25.0	10.0	21.0
440	17.0	29.0	13.0	24.0

NOTES:
1. Minimum air throw refers to the distance from the diffuser where the air velocity is 150 fpm. In maximum air throw, this velocity has dropped to 50 fpm.
2. Data is based on an area with a 9-ft ceiling. For higher ceilings, values may be reduced by one foot for each foot of height increase. For specific installations, minimum values can be reduced if properly qualified. Values are dependent on cfm only and are not affected by duct pressure.

Table 25 — Air Throw Data — 2-Way and 1-Way Director, 3-Slot Diffusers

37HS1 UNIT AIRFLOW (Cfm)	OPTIMUM AIR THROW (ft)			
	Heating		Cooling	
	1-Way Blow		2-Way Blow	
	Min	Max	Min	Max
40	2.0	7.0	2.0	5.0
50	4.0	9.0	3.0	6.0
60	7.5	12.0	3.5	7.5
70	8.0	15.0	4.0	9.0
80	9.0	18.0	4.5	10.5
90	10.0	20.0	5.0	11.5
100	11.0	22.0	6.0	13.0
110	12.0	24.0	7.0	15.0

37HS2 UNIT AIRFLOW (Cfm)	OPTIMUM AIR THROW (ft)			
	Heating		Cooling	
	1-Way Blow		2-Way Blow	
	Min	Max	Min	Max
80	2.0	7.0	2.0	5.0
100	4.0	9.0	3.0	6.0
120	7.5	12.0	3.5	7.5
140	8.0	15.0	4.0	9.0
160	9.0	18.0	4.5	10.5
180	10.0	20.0	5.0	11.5
200	11.0	22.0	6.0	13.0
220	12.0	24.0	7.0	15.0

37HS4 UNIT AIRFLOW (Cfm)	OPTIMUM AIR THROW (ft)			
	Heating		Cooling	
	1-Way Blow		2-Way Blow	
	Min	Max	Min	Max
160	8.5	16.0	5.0	7.0
200	10.0	20.0	6.0	10.0
250	11.0	21.0	7.0	13.0
300	12.0	22.0	8.0	17.0
350	14.0	23.0	9.0	19.0
400	15.0	25.0	10.0	21.0
440	17.0	29.0	13.0	24.0